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In the August number will appear:

Synopsis of North American Amaranthaceæ. IV, by EDWIN B. ULINE and WM. L. BRAY, *Lake Forest University.*

Notes from my herbarium. III, by WALTER DEANE, *Cambridge, Mass.*

A study of some anatomical characters of North American Gramineæ. V, by THEO. HOLM, *Dept. of Agriculture, Washington, D. C.*

Vegetal dissemination in the genus Opuntia, by PROF. J. W. TOUMEY, *University of Arizona, Tucson.*

BOTANICAL GAZETTE

JULY, 1895.

Undescribed plants from Guatemala and other Central American Republics. XV.

JOHN DONNELL SMITH.

Duguetia leiophylla Donnell Smith.—Folia oblongo-lanceolata acuminata basi obtusata vel acutiuscula glaberrima venulosa aureo-punctula, margine revoluto. Pedunculi uniflori, bractea versus basin sita parvula. Sepala minuta triangulari-ovata; petala ovalia subaequalia subtus lepidota, margine pubescente, ceterum glabra; torus disciformis crassus cum genitalibus glaber; styli concreti basi articulati ovaria aequantes eisque paululum crassiores.

A low, spreading tree (Thieme). Leaves slightly coriaceous shining, 3–4¼ × 1½–1¾in, petioles 2′ long. Peduncles terminal or becoming leaf-opposed, articulated above base, glandular-lepidote, 6–8′ long, bract ovate (1′) with pubescent margin. Sepals 3, free, thick, glandular-lepidote, margin pubescent, 1½′ long. Petals 6, 2-seriate, fleshy, imbricate, erecto-patent, explanate, 14–17 × 10–12′, each end rounded, shortly unguiculate. Torus somewhat obversely hemispherical, 1′ high, ecostate; gynophore plane, 2′ in diam., areolated with facets of carpels. Stamens all fertile, cuneate, 1 × ½′. Ovaries 50–70, columnar (⅔′), angular; ovule solitary, basal. Fruit not seen.

San Pedro Sula, Depart. S. Bárbara, Honduras, alt. 800ft, Apr. 1890, C. Thieme, no. 5,129.

Serjania punctata Radlk.—Scandens, fruticosa, glabra; rami subaequaliter 6-costati, costis obtusis, 6-sulcati, cortice e viridi pallescente; corpus lignosum compositum e centrali majore et peripherici 2–3 parvis, teretiusculis, centrali impositis; folia biternata; foliola lateralia ovata, obtusiuscula vel subacuta, sessilia, terminalia elliptica, breviter acuminata et mucronulata, basi attenuata, omnia remotiuscule leviter serrata, membranacea, reti venarum tenero nec prominente in-

structa, glabra, nec nisi glandulis microscopicis adspersa, punctis pellucidis conspicuis iisque prominentibus insignita, epidermide mucigera; petiolus communis nudus, partialium intermedius (in foliis inferioribus certe) superne marginatus; thyrsi solitarii, dense cincinniferi; cincinni stipitati, pedicellis prope basin articulatis; flores minores; sepala exteriora minutim puberula interioribus tomentellis dimidio breviora; fructus ——.

Rami thyrsigeri diametro 3^{mm}. Folia circ. 10^{cm} longa, 8^{cm} lata; foliola terminalia 4.5^{cm} longa, 2.5^{cm} lata, lateralia superiora 4^{cm} longa, 2^{cm} lata, inferiora dimidio minora; petiolus communis circ. 4^{cm} longus, partialium intermedius 2^{cm}, laterales 8^{mm} longi; stipulæ parvæ, ovato-triangulares. Thyrsi folia superantes, rhachi quam pedunculus communis paullo longiore; cincinni circ. 8-flori, stipite $3–4^{mm}$ longo suffulti, pedicelli 2^{mm} longi. Flores masculi: sepala exteriora 1.5^{mm}, interiora vix 3^{mm} longa. Petala angustiora, ex oblongo attenuata, 3.5^{mm} longa, 1.5^{mm} lata, intus laxe glanduligera; squamæ ciliolatæ, superiores crista bifida (laciniis acutis apice patulis) appendiceque brevi barbata, inferiores crista inaequaliter bicruri instructæ. Tori glandulæ superiores ovatæ, obtusæ, glabræ, laterales minores orbiculares. Stamina basi pilosiuscula. Germinis rudimentum ad angulos pilosiusculum.

Affinis *S. mucronulatæ* (in sect. XI, PHYSOCOCCUS), a qua differt costis ramorum obtusissimis, petiolo intermedio superne marginato, foliolorum punctis pellucidis majoribus.

Cuajiniquilapa, Depart. S. Rosa, Guat., alt. $2,500^{ft}$, Oct. 1894, Heyde & Lux, no. 6,091.

Paullinia hymenobracteata Radlk.—Scandens, fruticosa, hirsuta; rami trigoni vel subteretes, striato-sulcati, pilis patentibus e sufferugineo pallescentibus vestiti; corpus lignosum compositum e centrali majore et peripherici 3 minoribus partim quodammodo complanatis in centrale plus minus immersis; folia 5-foliolato-pinnata; foliola terminalia rhombea, in acumen acutum angustata, supra medium grossiuscule inaequaliter dentata, lateralia superiora ovalia, basi acuta, inferiora ovata, basi inaequilatera rotundata, apice acuta vel obtusata, a basi remotiuscule dentata, breviter petiolulata, membranacea, supra pilis setulosis adpressis laxe adspersa vel praeter nervos glabra, subtus subhirsuta necnon glandulis microscopicis curvatis vel geniculatis obsita, minutim pellucide punctata retique utriculorum lacticiferorum subtus instructa,

epidermide parum mucigera; rhachis nuda; stipulæ insignes, semicordato-deltoideæ, subacuminatæ, basi subbilobæ, inter lobos oblique affixæ, lobo interiore (i. e. folii medianam spectante) majore, scariosæ, extus hirsutæ; thyrsi axillares, inferiores folia subduplo superantes breviores paniculatim congesti, subhirsuti; bracteæ bracteolaeque conspicuæ, oblongæ, tenuiter scarioso-membranaceæ, concavæ, apice margineque necnon dorso secus medianam pilis longioribus obsitæ; flores mediocres pedicellique supra articulationes tomentelli.

Rami diametro 2–4^{mm}. Folia superiora 16–18^{cm} longa, 10–12^{cm} lata, inferiora duplo majora; foliola lateralia 5–6^{cm} longa, 2.5–3^{cm} lata, terminalia subduplo majora, sicca subfusca; petiolus communis circ. 4^{cm}, rhachis 3^{cm} longa, subhirsuta, petioluli 2–3^{mm} longi; stipulæ 7^{mm} longæ, 5–6 latæ. Cincinni stipitati, stipite 5–6^{mm} longo hirsuto; pedicelli 3^{mm} longi, infra medium articulati, infra articulationes hirsuti; bracteæ 5^{mm} longæ, 2^{mm} latæ, bracteolæ (prophylla) vix tertia parte minores. Alabastra obovata, 3–4^{mm} longa. Sepala interiora 4–5^{mm} longa, exteriora breviora. Petala obovata, intus glandulis microscopicis adspersa; squamæ margine villosiusculæ, superiores crista obcordata appendiceque deflexa squamam dimidiam longitudine superante villosa instructæ. Tori glandulæ ovatæ, basi villosiusculæ. Stamina pilosa. Germinis rudimentum puberulum.

Affinis videtur *Paullineæ monogynæ* Radlk. (in sect. XII, CALOPTILON). Ad eandem *P. hymenobracteatam* pertinet Tate no. 59!, ann. 1867 in Nicaragua lecta, in Hb. Kew. servata (*Paullinia sp.* Hemsley in Salvin et Godm. Biol. Centr.-Am., Bot. **1**: 211. 1879–81. [no. 17.]).

Malpais, Depart. S. Rosa, Guat., alt. 4,000^{ft}, Sept. 1894, Heyde & Lux, no. 6,093.

Dalea cinerea Moric. ex sched. Bentham in herb. Kew.; erecta, sublignosa, caule striato, undique fulvo-tomentoso, ramis erectis, foliis imparipinnatis, pubescentibus, foliolis 4–5 jugis, subtus glandulosis, floribus in spicas densas, terminales, congesti, siccitate nigricantibus.

Suffrutex videtur 1.5–2^{ped}. Caules erecti, ramis ascendentibus, dense fulvo-tomentosis. Stipulæ lineari-setaceæ, rigidiusculæ, 1–1.5^{lin} longæ, folia vix pollicem longa, usque ad basim petioli foliolata, petiolo gracili, fulvo-pubescente. Foliola 3–4 juga, sessilia, ovata, obtusa, utrinque pubescentia, ciliata, subtus glandulis nigris irregulariter obsita, 2^{lin} longa.

Spicæ ad apicem ramorum terminales, densifloræ, 1.5–2[poll] longæ, siccitate nigricantes. Bracteæ late cordato-ovatæ, carinatæ, longe acuminatæ, florem amplectentes, 1.5[lin] longæ, persistentes. Calyx pubescens, coriaceus, 5-dentatus, lacinia carinali longiore, tubo 10-nervio, glanduloso, 1.5[lin] longo. Vexillum cordato-orbiculare, longe stipitatum, carina brevius, 1.5[lin] longum. Alæ rectæ, stipitatæ, vexillum vix superantes, lateraliter plicatæ. Carina recta, obtusa, stipitata, glandulis raris notata, vexillum superans 2[lin] longa. Stamina monadelpha, vagina supra fissa. Antheræ parvæ, nutantes, ad apicem glandulosæ. Ovarium sessile, ovatum, dense tomentosum. Legumen calyce coriaceo inclusum membranaceum, pubescens.

Haec planta ad specimen in herb. Kew. servatum et a cl. Bentham sub nomine *D. cinerea* Moric. labellatum pertinet. Sed nunquam in libris, herbariis, etc. Moricand, hoc nomen occurrit. Verisimiliter hoc nomen errore cl. Bentham hic adest et planta nondum descripta fuit. Nobis species bene delimitata videtur sed genus Dalea revisionem aegre caret. (M. Micheli.)

Santiago, Depart. Zacatepéquez, Guat., alt. 6,500[ft], 1891, Rosalió Gómez, no. 999.—Embaulada, Depart. Zacatepéquez, Guat., alt. 5,500[ft], Dec. 1889, Heyde & Lux, no. 4,465.

GLIRICIDIA MACULATA HBK., var. **multijuga** Micheli. Differt foliolis 7–8- nec 3–5-jugis, minoribus et magis pubescentibus.

S. Rosa, Depart. S. Rosa, Guat., alt. 3,000[ft], Apr. 1892, Heyde & Lux, no. 3,296.

ÆSCHYNOMENE AMERICANA L., var. **longifolia** Micheli. Quam planta typica in omnibus partibus major, magis robusta, folia longiora, foliolis latioribus, magis nervosis, racemi densiores, flores longiores, carina obtusa.

Cassillas, Depart. S. Rosa, Guat., alt. 4,000[ft], Oct. 1892, Heyde & Lux, no. 4,172.—S. Juan Utapa, Depart. S. Rosa, Guat., alt. 4,500[ft], Oct. 1894, Heyde & Lux, no. 6,099.

Desmodium Hondurense Micheli; lignosum vix scandens dense velutino-tomentosum, stipulis linearibus, foliis trifoliolatis, stipellatis, floribus parvis in racemos densos, axillares congestis, legumine dense tomentoso, articulis sibi invicem replicatis.

Frutex ramulis gracilibus, tomentosis. Folia petiolata, pinnatim trifoliolata. Stipulæ lineares, acutæ, tomentosæ.

Petiolus communis dense tomentosus, 4^{lin} longus. Foliola ovata vel anguste ovata, obtusa, terminale stipellatum, distans, 1½–2^{poll} longum, 5–6^{lin} latum, lateralia minora, senilia omnia crassiuscula, superne puberula, subtus dense crispo-tomentosa. Racemi axillares vel terminales, sub anthesi 4–5^{poll} longi, rachi fere a basi florifero. Flores breviter pedicellati, secus rachin ternati vel fasciculati, purpurascentes, parvi, congesti; bracteæ parvæ, lineares, caducæ. Calyx fere bilabiatus, labio superiore tridentato, inferiore bidentato, dense tomentosus, vix lineam longus. Vexillum basi nudum, latum, fere orbiculare, breviter unguiculatum, 2½^{lin} longum, alæ carinæ leviter adhaerentes, 2^{lin} longæ, carina vix curvata, late obtusa vel truncata. Stamen vexillare e basi liberum. Ovarium 3–4-ovulatum. Legumen (junius) dense tomentosum, articulis 3–4, omnibus fertilibus, e calyce exsertis, sibi invicem replicatis.

Species verisimiliter e sectione Chalarium (nisi stamine vexillari libero); fructus structura ad *D. plectocarpum* Hemsley Diag. Pl. Nov. pars 3, p. 46 pertinet.

San Pedro Sula, Depart. S. Bárbara, Honduras, alt. 600–1,000^{ft}, Febr. 1887 and Apr. 1890, C. Thieme, nos. 5,197 & 5,207.

CALLIANDRA PORTORICENSIS Benth., var. **multijuga** Micheli.—Inflorescentia, floribus, legumine omnino *C. Portoricensis* Benth.; differt pinnis 7–8- nec 2–4-jugis.

Casillas, Depart. S. Rosa, Guat., alt. 4,000^{ft}, Jan. 1893, Heyde & Lux, no. 4,148.—San Juan Utapa, Depart. S. Rosa, alt. 4,500^{ft}, Oct. 1893, Heyde & Lux, no. 6,098.

Pithecolobium insigne Micheli; puberulum, foliolis bigeminis, amplis, floribus spicatis, magnis, spicis ad apicem ramorum racemosis.

Arbor vel frutex, in partibus junioribus puberulum, caeterum glabrescens, stipulæ ignotæ. Folia bipinnata, pinnis unijugis. Petiolus communis gracilis, 2–2½^{poll} longus, glandulis ad apicem et inter pinnas parvis, vix elevatis rachis 1½^{poll} longus. Foliola unijuga, ampla, 5^{poll} longa, 1½–2^{poll} lata, glabra, penninervia, subcoriacea, oblique ovata, ad apicem sensim attenuata, longiuscule acuminata, acuta. Pedunculi ad apicem ramorum longe laxeque racemosi; spicæ 5–7^{poll} longæ, supra medium floriferæ, rachi velutine puberulo. Flores sessiles, secus rachin haud congesti, bracteis minutis fulti. Calyx dense velutino-puberulus, fere 2^{lin} longus, 5–7-

dentatus. Corolla velutina, 3^{lin} longa, 5–7-fida. Stamina indefinita, filamentorum tubo corollam paullo excedente. Antheræ parvæ, eglandulosæ. Pollen in massas coalitum. Ovarium sessile, puberulum. Legumen ignotum.

Species magnitudine florum et foliorum insignis; fructu absente determinatio incerta. Notis plurimis tamen ad genus Pithecolobium rite pertinere videtur. A sectione Caulanthon imprimis affini differt petiolis glandulosis et pedunculis racemosis.

San Pedro Sula, Depart. S. Bárbara, Honduras, alt. 600^{ft}, Apr. 1890, C. Thieme, no. 5,208.

CENTRADENIA FLORIBUNDA Planch., var. **grandifolia** Cogn.—Planta robustior. Folia magna, glabrata, majora 6–11^{cm} longa et 1.5–3^{cm} lata.

Palin, Depart. Amatitlan, Guat., alt. 3,560^{ft}, Febr. 1892, J. D. S., no. 2,645.—Rio Samalá, Depart. Retalhuleu, Guat., alt. 1,700^{ft}, Apr. 1892, J. D. S., no. 2,651.

Arthrostemma hirtella Cogn.; caule herbaceo; ramis junioribus petiolis pedunculis calycibus foliisque subtus setulis brevissimis adpressis sparse hirtellis; foliis parvis, breviter petiolatis, elliptico-ovatis, obtusis, basi obtusiusculis, margine integerrimis vel obscure crenulatis, sparse adpresseque setoso-ciliatis, trinerviis; floribus solitariis, axillaribus vel ad ramulum brevissimum terminalibus; calycis tubo campanulato, segmentis anguste triangularibus, vix ciliatis, tubo subaequilongis; staminibus valde inaequalibus, majorum connectivo basi profunde bifido, minorum connectivo ultra insertionem filamento vix porrecto basi integro; ovario superne breviter denseque setoso.

Rami satis graciles, acutiuscule tetragoni. Petiolus gracillimus, 2–4^{mm} longus. Folia rigidiuscula, supra intense viridia, subtus pallidiora, 12–22^{mm} longa, 8–15^{mm} lata. Pedicelli graciles, 1–1.5^{cm} longi. Calycis tubus 6^{mm} longus, apice 4^{mm} latus; segmenta subreflexa, 5^{mm} longa, basi 3^{mm} lata. Petala purpurea, anguste obovata, brevissime glanduloso-ciliata, 12^{mm} longa. Capsula obovoidea, 7–8^{mm} longa.

San Miguel Uspantán, Depart. Quiché, Guat., alt. 6,000^{ft}, Mch. 1892, Heyde & Lux, no. 3,328.

Conostegia viridis Cogn.; ramis junioribus petiolis pedunculis calycibusque densiuscule furfuraceo-puberulis; foliis membranaceis, ovatis, breviuscule acuminatis, basi rotundatis vel subemarginatis, acute minuteque duplicato-dentatis ciliatis-

que, 5-plinerviis fere 5-nerviis, supra tenuissime punctato-furfuraceis et breviter sparseque setosis, subtus ad nervos nervulosque leviter stellato-furfuraceis caeteris glabratis; floribus 5-meris, subsessilibus; alabastris anguste obovoideis, obtusiuscule acuminatis.

Rami robustiusculi, obscure tetragoni. Petiolus 2.5–3.5^{cm} longus. Folia supra intense viridia, subtus laete viridia, 10–13^{cm} longa, 6–7^{cm} lata, nervis nervulisque subtus satis prominentibus. Paniculæ corymbiformes, multifloræ fere 1^{dm} longæ. Alabastra cinerea, 6–7^{mm} longa, 4^{mm} crassa. Petala oblique obovata, 5^{mm} longa. Antheræ oblongæ, subrectæ, fere 2^{mm} longæ. Stylus crassus, 5^{mm} longus, stigmate non dilatato. Fructus nigricans, depresso subglobosus, 5–6^{mm} crassus.—Species *C. subcrustulatæ* Triana (Cogn. in DC. Monogr. Phan. **7**: 709) proxima, sed foliis 5-plinerviis, etc.

San Felipe, Depart. Retalhuleu, Guat., alt. 2,050^{ft}, Apr. 1892, J. D. S., no. 2,650.

Var. **angustifolia** Cogn.—Petiolus 5^{cm} longus. Folia oblonga, distincte 5-plinervia, basi acuta vel subacuta 17^{cm} longa, 6–6.5^{cm} lata.

Primavera, Depart. Sololá, Guat., alt. 760^{ft}, July 1891, Shannon, no. 487.

Miconia Donnell-Smithii Cogn. (§ AMBLYARRHENA); glaberrima; ramis teretiusculis; foliis satis parvis, breviter petiolatis, pergamentaceis, lanceolatis, longuiscule angusteque acuminatis, basi cuneatis, integerrimis, leviter triplinerviis; floribus 5-meris, longuiscule pedicellatis; calycis tubo subturceolato, dentibus anguste triangularibus, tubo triplo brevioribus; stylo apice truncato.

Rami gracillimi, leviter ramulosi. Petiolus gracilis, circiter 1^{cm} longus. Folia 5–7^{cm} longa, 1.5–2^{cm} lata, nervis supra impressis, subtus valde prominentibus, nervulis paulo distinctis. Paniculæ pyramidatæ, laxæ, submultifloræ, 6–9^{cm} longæ; pedicelli 4–7^{mm} longi, sub apice articulati. Calycis tubus 3^{mm} longus, apice leviter constrictus; dentes erecti, vix 1^{mm}longi. Petala subrotundata, 1.5^{mm} longa. Antheræ rectæ, 1.5^{mm} longæ. Stylus crassiusculus, rectus, 4–5^{mm} longus.—Species *M. pergamentaceæ* Cogn. (DC. Monogr. Phan. **7**: 873) proxima.

San Miguel Uspantán, Depart. Quiché, Guat., alt. 6,000^{ft}, Apr. 1892, Heyde & Lux, no. 3,333.

Miconia alpestris Cogn. (§ CREMANIUM); ramis superne obtuse tetragonis et leviter compressis, junioribus petiolis pedunculis calycibusque dense stellato-furfuraceis; foliis majusculis, longiuscule petiolatis, obovato-lanceolatis, longiuscule subabrupteque acuminatis, basi late cuneatis, integerrimis, triplinerviis fere trinerviis, supra primum furfuraceis demum glabris, subtus ad nervos densiuscule stellato-furfuraceis cæteris glabratis; floribus 5-meris, brevissime pedicellatis calyce subhemisphærico, dentibus brevibus, obtusiusculis, carnosulis; antheris biporosis; stylo brevi, apice truncato.

Rami robustiusculi, apice fuscescentes. Petiolus satis gracilis, fuscescens, 2–5^{cm} longus. Folia erecto-patula, rigidiuscula, supra intense viridia, subtus satis pallidiora, 12–17^{cm} longa, 4–7^{cm} lata, nervis subtus satis prominentibus. Paniculæ late pyramidatæ, multifloræ, 5–8^{cm} longæ; pedicelli sæpius vix 1^{mm} longi. Calycis tubus fuscescens, 2^{mm} longus, 2.5^{mm} latus; dentes erecti, 0.5^{mm} longi. Petala obovata, apice leviter emarginata, 2^{mm} longa. Antheræ 1^{mm} longæ. Stylus rectus, 2^{mm} longus.—Species *M. carneæ* Cogn. (DC. Monogr. Phan. **7**: 912) proxima. San Miguel Uspantán, Depart. Quiché, Guat., alt. 7,500^{ft}, Apr. 1892, Heyde & Lux, no. 3,334.

Clidemia radicans Cogn. (§ CALOPHYSOIDES); caule brevi, repente, radicante; ramis junioribus petiolis pedunculisque brevissime denseque stellato-puberulis; foliis valde inæqualibus et dissimilibus, integerrimis, trinerviis, supra primum puberulis demum glabris, subtus ad nervos nervulosque densiuscule stellato-furfuraceis cæteris glabratis majoribus brevissime petiolatis satis obliquis oblongis acutis basi leviter inæqualibus subrotundatis, minoribus sessilibus ovatis vel suborbicularibus; racemis axillaribus vel interdum terminalibus, breviusculis, paucifloris; floribus 5-meris, breviter pedicellatis; calyce urceolato, leviter furfuraceo, brevissime 5-dentato.

Rami graciles, breviusculi, leviter flexuosi, teretiusculi, cinerei, paulo ramulosi. Petiolus satis gracilis, 2–5^{mm} longus. Folia membranacea, supra saturate viridia, subtus viridi-cinerea; majora erecta vel erecto-patula, 10–17^{cm} longa, 3–5.5^{cm} lata; minora patula, 1.5–4^{cm} longa, 14–20^{mm} lata. Racemi erecti, 4–6^{cm} longi; pedicelli 2–3^{cm} longi. Calyx cinereo-fuscus, ultra medium satis constrictus, 2.5^{mm} longus, inferne 2^{mm} latus. Petala patula, suborbicularia, 1.5^{mm} lata. Antheræ lineares, leviter arcuatæ, 1.5^{mm} longæ. Stylus rectus, 3^{mm}

longus, stigmate punctiformi. Bacca depresso-sphærica, distincte 10-costata, intense cyanea, 4–5^{mm} crassa.

Jiménez, Llanos de S. Clara, Comarca de Limón, Costa Rica, alt. 650^{ft}, Apr. 1894, J. D. S., no. 4,789.—Collected also by M. Pittier in the valley of Rio Reventazon, Costa Rica, 1893 (no. 8,123).

Clidemia glandulifera Cogn. (§ SAGRÆA); ramis junioribus pedunculis calycibusque brevissime denseque stellato-tomentosis et pilis patulis brevibus glandulosis densiuscule vestitis; foliis longiuscule petiolatis, satis disparibus, anguste ovatis, acutis vel breviter acuminatis, basi rotundatis, integerrimis, supra pilis simplicibus brevissimis dense hirtellis, subtus brevissime denseque stellato-pilosis, majoribus 7-nerviis, minoribus 5-nerviis; paniculis longiusculis, pyramidatis, multifloris; floribus 4-meris, subsessilibus; calyce campanulato, brevissime dentato.

Rami satis graciles, juniores teretiusculi, sordide fusci. Petiolus brevissime denseque stellato-tomentosus et sparsissime breviterque glandulosa-pilosus, 3–7^{cm} longus. Folia submembranacea, supra intense viridia, subtus cinerea, 12–15^{cm} longa et 7–8^{cm} lata, minora subdimidio breviora et angustiora. Paniculæ patulæ, 7–10^{cm} longæ. Calyx cinereo-fuscus, 3^{mm} longus. Petala obovata, 3^{cm} longa. Antheræ lineares, subrectæ, 2.5–3^{mm} longæ. Stylus capillaris, 5–7^{mm} longus, stigmate punctiformi. Bacca nigricans, subglobosa, 4–5^{mm} crassa.

San Miguel Uspantán, Depart. Quiché, Guat., alt. 6,000^{ft}, Apr. 1892, Heyde & Lux, no. 3,329.

Pittiera trilobata Cogn.; ramis junioribus petiolis cirrhisque breviter sparseque pilosulis; foliis breviuscule petiolatis, rigidiusculis, late ovatis, leviter vel usque ultra medium trilobatis, basi profundiuscule emarginatis, supra scabris, subtus ad nervos densiuscule breviterque asperis caeteris brevissime denseque pubescenti-scabriusculis;calyce brevissime denseque puberulo, tubo breviter campanulato-subcylindrico, segmentis triangulari-lanceolatis, tubo satis longioribus; corollæ segmentis obovato-oblongis, acutis vel breviter acuminatis; staminum filamentis basi pilosulis.

Rami graciles, elongati, paulo ramulosi, leviter sulcati. Petiolus satis gracilis, profunde striatus, 2–5^{cm} longus. Folia supra intense viridia, subtus viridi-cinerea, margine remotiuscule spinuloso-denticulata, 7–10^{cm} longa, 6–9^{cm} lata; nervi

subtus paulo prominentes, duo laterales trifurcati imum sinum leviter marginantes. Cirrhi robusti, elongati, sulcati, saepius 5-fidi. Pedunculus masculus satis gracilis, brevissime et densiuscule puberulus, 7–26^{cm} longus. Calycis tubus 10–13^{mm} longus, superne circiter 1^{cm} latus; segmenta erecto-patula, 15–18^{mm} longa, basi 5^{mm} lata. Corolla membranacea, utrinque leviter furfuraceo-puberula, 2.5^{cm} longa. Staminum filamenta filiformia, 11–12^{mm} longa; capitulum antherarum ovoideo-conicum, 1^{cm} longum, 6^{mm} crassum. Fructus oblongus, laevis, 8^{cm} longus, 3^{cm} crassus. Semina ovata, apice obtusa, basi obscure tridentata, margine subalata, 1^{cm} longa, 7^{mm} lata, 1.5^{mm} crassa.

Buena Vista, Depart. S. Rosa, Guat., alt. 5,500^{ft}, Dec. 1892, Heyde & Lux, no. 4,189.

Schizocarpum Guatemalense Cogn.; foliis longiuscule petiolatis, ambitu ovatis, leviter vel usque ad medium trilobatis, supra glabratis, subtus brevissime et densiuscule puberulis, basi leviter emarginatis; nervis lateralibus imum sinum non vel vix marginantibus; calycis tubo brevissimo, late campanulato, segmentis triangulari-linearibus, tubo multo longioribus; corollæ segmentis longe acuminatis; fructu anguste ovoideo, apice longiuscule rostrato.

Rami gracillimi, elongati, sulcati, glabrati vel leviter puberuli. Petiolus gracilis, striatus, brevissime et densiuscule hirtellus, 2–4^{cm} longus. Folia tenuiter membranacea, intense viridia, margine vix denticulata, 6–10^{cm} longa, 4–7^{cm} lata; lobus terminalis triangularis vel oblongus, acutus, laterales multo breviores, obtusi. Cirrhi filiformes, inaequaliter bifidi, sulcati, glabrati. Pedunculus masculus gracilis, densiuscule et brevissime puberulus, 3–4^{cm} longus. Calyx furfuraceus et longiuscule sparseque pilosus, tubo 3^{mm} longo, 4–5^{mm} lato, segmentis erecto-patulis, 8–12^{mm} longis, basi 2^{mm} latis. Corolla pallide flava, anguste campanulata, vix furfuraceo-puberula, fere 3^{cm} longa. Staminum filamenta 6–7^{mm} longa; capitulum antherarum 6^{mm} longum. Pedunculus fructiferus robustiusculus, 7–8^{mm} longus. Fructus sparse pilosus, (maturus?) 3.5^{cm} longus, 17^{mm} crassus.

Carrizal, Depart. S. Rosa, Guat., alt. 5,000^{ft}, Nov. 1892, Heyde & Lux, no. 4,186.

Cyclanthera Donnell-Smithii Cogn. (§ EUCYCLANTHERA); ramis glaberrimis; foliis breviter petiolatis, trifoliolatis; foliolis breviter petiolulatis, undulato-denticulatis, glabratis, supra

sparse punctato-scabriusculis, mediano oblongo-lanceolato, acutissime breviterque acuminato, lateralibus valde asymmetricis, ovato-oblongis, acutis; cirrhis bifidis; racemis masculis petiolo brevioribus, paucifloris; floribus minutis.

Rami graciles, elongati, angulato-sulcati. Petiolus gracilis, striatus, glaber, 2–3^{cm} longus; petioluli leviter puberuli, 3–5^{mm} longi. Foliola tenuiter membranacea, intense viridia; terminale 6–7.5^{cm} longum, 2–2.5^{cm} latum, basi acutum; lateralia 3.5–5^{cm} longa, 1.5–2.5^{cm} lata, basi extrinsecus auriculata. Cirrhi graciles, longissimi, sulcati, glabri. Pedunculus communis masculus filiformis, sulcatus, leviter puberulus, 0.5–1.5^{cm} longus; pedicelli capillares, patuli, 2–3^{mm} longi. Flores ut videtur vix 2^{mm} lati. Calycis dentes subnulli.—Species *C. gracillimæ* Cogn. (DC. Monogr. Phan. **3:** 834) proxima.

San Miguel Uspantán, Depart. Quiché, Guat., alt. 6,000^{ft}, Apr. 1892, Heyde & Lux, no. 3,345.

Burmeistera cyclostigmata Donnell Smith. — Suffrutex orgyalis ramosus. Folia longe petiolata lanceolato-elliptica, termino utroque praecipue superno acuminato, margine glanduloso-punctulo, costis lateralibus utrimque 10–12 supra impressis subtus prominulis, venulis pellucidis. Pedunculi folia superantes. Calycis tubus longiuscule campaniformis lobis oblongis sublongior. Corollæ tubus dorso breviter fissus, lobi valde inaequales recurvi secundi. Antheræ omnes prorsus nudæ. Stigmatis magni lobi suborbiculares.

Leaves $3\frac{1}{2}$–$5 \times 1\frac{1}{2}$–$1\frac{3}{4}^{in}$, paler beneath, lateral nerves forming intramarginal arches, base often unequal, petioles 1–$1\frac{1}{2}^{in}$ long. Peduncles 3–$4\frac{1}{2}^{in}$ long. Tube of calyx $5 \times 2\frac{1}{2}^{l}$, sometimes narrowing at base, lobes 3–4^{l} long and obtuse. Tube of corolla 6^{l} long, narrowed above; limb unequally partite, oblique, inflated on lower side; 2 superior segments 11–13^{l} long, twice exceeding the 3 inferior; all linear, acute, arcuately deflexed to lower side. Staminal tube adnate to base of corolla, pubescent, $1\frac{1}{2}^{in}$ long; anthers lightly recurving, the 3 superior 4^{l} long and twice exceeding the others. Placentas peltate, oval, entire. Lobes of stigma 2–$2\frac{1}{2}^{l}$ in diam., barbate beneath.—Nearest to *B. virescens* Benth. et Hook.

Estrella, Prov. Cartago, Costa Rica, alt. 4,400^{ft}, Apr. 1888, Juan J. Cooper, no. 5,845.

Psammisia symphystemona Donnell Smith.—Tota glabra. Rami teretes. Folia subdisticha coriacea elliptica longe caudato-acuminata basi obtusa 3–5-plinervia minutim

reticulata, venis intramarginalibus transversis crebris. Racemi sessiles, rhachi brevissima, pedicellis confertis gracilibus basi bracteatis supra basin bibracteolatis. Stamina aequalia tertiam partem corollæ attingentia, filamentis in tubum connatis, antheris prope basin affixis; omnibus ad apicem connectivi 2-calcaratis.

Epiphytal, 8–10^{ft} long (Cooper). Branches pale, internodes 9–15^{l} long. Leaves 5–7 × 2–3^{in}, more narrowing above the middle than below, caudate prolongation 9–12^{l} long, interior 2 lateral nerves arising 3–4^{l} above base and like midrib very prominent beneath, the exterior 2 basal and obscure. Petioles 2^{l} long. Rhachis 2–5^{l} long; pedicels articulated at base, 5–8^{l} long; bracts ovate; bracteoles lanceolate, glandular-denticulate, like bracts very minute and colored. Tube of calyx campanulate, 2^{l} high; limb as long, spreading; lobes round, mucronate-acuminate, 1^{l} long. Corolla red, sprinkled toward apex with red glands, cylindrical-tubular, 13–15^{l} long, tapering above stamens, lobes triangular-oblong, 2 × 1^{l}. Filaments persistently connate, 2^{l} long; anther-cells 2^{l} long, twice exceeding their tubes. Style exsert.

Mariposa, Prov. Alajuela, Costa Rica, alt. 5,500^{ft}, May 1887, Anastasio Alfaro, no. 5,842.

GAULTHERIA ODORATA HBK., var. **Costaricensis** Donnell Smith.—Folia orbiculari-ovata subintegra, costis lateralibus utrimque 3–4 subtus prominentibus usque ad apicem fere adscendentibus. Bracteolæ semipollicares.

Estrella, Prov. Cartago, Costa Rica, alt. 4,400^{ft}, Mch. 1888, Juan J. Cooper, no. 5,841.

Calceolaria Irazuensis Donnell Smith. (§CHEILONCOS Wettst.)—Herbacea adsurgens ferrugineo-glanduloso-pubescens. Folia ovato-lanceolata basi cuneata, uniuscujusque jugi alterum aliquantum minus, grosse dentata supra puberula subtus pallida et praeter nervos glabra petiolata. Pedunculi terminales 2 longissimi foliis ternatis bracteati, cymis corymbiformibus nutantibus, pedicellis filiformibus, floribus inter maximas. Corollæ labium superius semi-globosum calycem subaequans ab inferiori obovato breviter aperto 3-plo superatum. Antherarum loculi confluentes.

Stem stout, sparingly branched, 3–4^{ft} long. Leaves 2½–4 × 1–1½^{in}, petioles 3–6^{l} long. Peduncles 3–4^{in} long; bractlets 2, foliaceous, unequal, ¾–1¼^{in}, subtending viscid-pubescent corymbs 1¾–2½^{in} high and 7–12-flowered. Calyx-segments

nearly free, ovate-acuminate, 3×2^{l}, 5-nerved, tipped with a gland. Corolla obovate, $10–12 \times 5–6^{l}$, yellow, pluri-nerved, sprinkled with minute dusky glandular hairs, barbate at insertion of stamens. Anthers stout, arcuate; cells $\frac{3}{4}^{l}$ long, divaricate from apex of shorter filament. Stigma incrassate. Capsule glandular-punctate.

Moist, shaded slopes of Volcán Irazú, Prov. Cartago, Costa Rica, alt. 9,000^{ft}, Mch. 1894, J. D. S., no. 4,904.

Spathacanthus Donnell-Smithii Lindau.—This determination of no. 1,030 must be substituted for the erroneous one, *Macfadyena simplicifolia* Botan. Gaz. **16:** 198, the specific name being dropped as inappropriate for an *Acanthacea*.

Pisonia macranthocarpa Donnell Smith. (*P. aculeata* L., var. *macranthocarpa* Donnell Smith in Botan. Gaz. **16:** 198). —Arbusculus inermis. Folia obovata vel oblongo-elliptica apice rotundata vel plus minus obtuse acuminata in petiolum cum costa et cymis pubescentem attenuata ceterum glabra. Cymæ corymboso-fasciculatæ, pedicellis longiusculis (fructiferis valde elongatis), perigonio tubuloso-infundibuliformi, floribus hermaphroditis. Anthocarpia magna oblongo-obovata ad costas glandulis pluriserialibus longe stipitatis muricata.

Erect, 12–18^{ft} high, branchlets occasionally spine-like. Leaves opposite, often fasciculate in axils, $1\frac{1}{2}–2\frac{1}{2} \times \frac{3}{4}–1\frac{1}{2}^{in}$, the younger sprinkled beneath with cystoliths; petioles 3–5^{l} long, marginate, at length glabrous. Peduncles axillary and terminal, 8–12^{l} long, in fruit elongated; corymbs subglobose (1^{in}); bracts orbicular-ovate (1^{l}); bractlets near apex of pedicel 3, oblong ($\frac{3}{4}^{l}$). Perigonium puberulous, $2\frac{1}{2}–3^{l}$ long, twice to thrice exceeding pedicel, lobes 5 and ovate ($\frac{1}{4}^{l}$). Stamens nearly free, 6–7, didynamous, exsert, anthers orbicular. Style included, stigma minutely laciniate. Cymes in fruit 5–6^{in} in diam., pedicels $1\frac{1}{2}–2^{in}$ long; anthocarps $9 \times 4\frac{1}{2}^{l}$, flavo-tomentulose, stipes of glands lageniform ($\frac{1}{4}^{l}$).

Escuintla, Depart. Escuintla, Guat., alt. 1,100^{ft}, Apr. 1890 and Feb. 1892, J. D. S., nos. 2,091 and 1,230.—Los Verdes, Depart. Amatitlan, Guat., alt. 3,500^{ft}, Oct. 1893, Heyde & Lux, no. 6,301.

TRIPLARIS MACOMBII Donnell Smith in Botan. Gaz. **19:** 237, var. **rufescens** Donnell Smith.—Folia utrimque praecipue subtus ad nervos pilosiuscula. Calycis rufescentis lobi interiores plerumque plus minus exserti, interdum lineares exteriorum dimidium paene aequantes.

Tree 30–50^{ft} high; flowers brick-red.

Mazatenango, Depart. Suchitepéquez, Guat., alt. 1,200^{ft}, Jan. 1894, Heyde & Lux, no. 6,375.

Pseudolmedia oxyphyllaria Donnell Smith.—Primo sericea, cito aetate provectiore glabrata. Folia semipedalia et ultra ter quaterve longiora quam latiora oblongo-lanceolata in acumen longiusculum obtusum angustata ad basin acuta subinaequilatera falcata, costis subtus prominentibus in utroque latere circa 20. Capitula mascula singula vel 2–5-glomerata; involucri bracteæ externæ deltoideæ, internæ ovatæ, cunctæ autem acutæ; receptaculi concavi magni bracteolæ rhomboideo- vel lanceolato-spatulatæ. Stamina numerosissima, antheris nudis ad basin breviter auriculatis.

Tree 20–30^{ft} high. Branchlets terete. Leaves 6–8 × 1½–2¼^{in}, glabrous; petioles pubescent, 3^{l} long. Heads about 5^{l} in diam.; bracts cano-sericeous with scarious margins, the interior 3^{l} long; bractlets cano-sericeous, lacerate, exceeding stamens. Anthers 1^{l} long. Female heads not seen.

Slopes of Volcán Tecuamburro, Depart. S. Rosa, Guat., alt. 6,000^{ft}, Febr. 1893, Heyde & Lux, no. 4,429.

Pilea Costaricensis Donnell Smith.—Dioica glabra. Folia in eodem jugo maxime inaequimagna admodum autem conformia, alterum nempe majus oblongo-ellipticum longiuscule cuspidato-acuminatum basi aliquantulum inaequilaterum et plerumque obtusum longe petiolatum, alterum quadruplo minus breviusque petiolatum oblongo-lanceolatum a medio utrimque sensim angustatum, ambo 3-nervia subtus pallida et evenia supra basin integram incurvo-crenulata, nervis lateralibus apicem fere attingentibus. Cymæ brevissime pedunculatæ, masculæ a petiolo folii majoris feminæ a petiolo folii minoris superatæ.

Herbaceous, ascending 1–2^{ft} from a rooting base, branching. Leaves, especially beneath, occupied by linear cystoliths; the larger in the pair 3½–5½ × 1½–1¾^{in}, more narrowing above the middle than below, cuspidate tip 4–6^{l} long, petioles 1–2^{in} long. Masculine cymes 6–8^{l} high, perianth 2^{l} in diam. with oblong segments exceeded by anthers; feminine cymes less evolute, exterior segments of perianth scarious-tipped and twice exceeded by obliquely oval ($\frac{3}{4}^{l}$) achenium.

Estrella, Prov. Cartago, Costa Rica, alt. 4,400^{ft}, Apr. 1888, Juan J. Cooper, no. 5,952.

Dioscorea calyculata Donnell Smith. (§ EPISTEMON Griseb. in Fl. Brasil.)—Omnibus in partibus glaber. Folia tenuiter membranacea inter minora subcordata vel subcordato-ovata acutissime acuminata et mucrunculata, basi ima cuneata cum nervis basalibus 3–5 in petiolum marginatum decurrente. Racemi filiformes elongati, pedunculis furcatis, pedicellis solitariis basi bracteolatis subflore bibracteolatis. Perianthii masculini minimi infundibulari-rotati segmenta exteriora orbicularia, interiora oblongo-obovata.

Herbaceous, twining. Leaves alternate, $1\frac{3}{4}$–$2\frac{1}{2}$ × $1\frac{1}{4}$–2^{in}, the younger ovate-lanceolate with a filiform mucro, petioles 6–14^{l} long. Racemes 6–10^{in} long, axillary or composing an elongated terminal panicle; peduncles 2–3-furcate, 2–3^{in} long; pedicels 1^{l} long; basal bracteole filiform, exceeding pedicel; apical bracteoles opposite, ovate ($\frac{1}{3}^{l}$), persistent. Tube of male perianth very short, segments $\frac{2}{3}^{l}$ long; stamens 6, all perfect, inserted at base of segments; filaments flat, attenuate upwards, incurved at apex, exceeding perianth; anthers many times shorter than filament, oblong, arcuate, affixed at middle. Rudimentary ovary globose, exceeding tube of perianth, styles united and at apex 3-lobed. Pistillate flowers and fruit not seen.

Alajuela, Prov. Alajuela, Costa Rica, alt. $2,700^{ft}$, Nov. 1887, Anastasio Alfaro, no. 5,959.—Guachipilin, Depart. S. Rosa, Guat., alt. $2,500^{ft}$, Nov. 1893, Heyde & Lux, no. 6,260.

Baltimore, Md.

Contributions to the embryology of the Ranunculaceæ.

WITH PLATES XVII–XX.

DAVID M. MOTTIER.

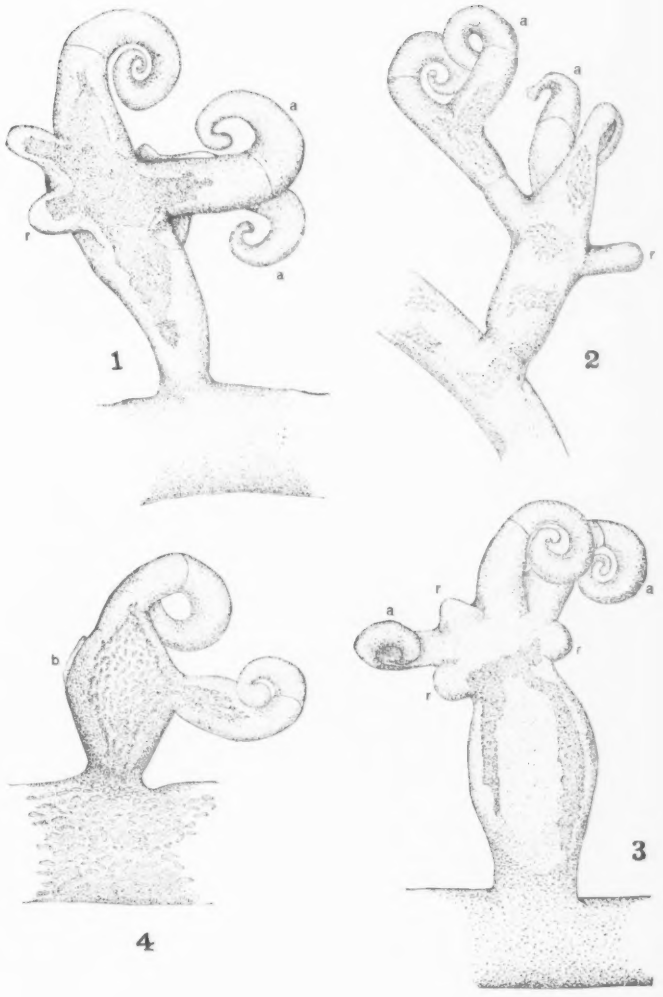
(Concluded from page 248.)

Of the three species of Ranunculus examined, *R. abortivus* is most abundant in this vicinity thriving well in the dry soil of open woods and meadows, while the other two, *R. recurvatus* and *R. septentrionalis*, seem to prefer the moist soil of more dense and shady woods and along water courses. We shall direct our attention first to

Ranunculus abortivus.—The carpophyll may be said to consist of a short stalk or petiole and a broader portion, the lamina. The ovule arises as a small protuberance at the junction of petiole and lamina, but, of course, before any differentiation into these two parts is perceptible. The lamina soon broadens, the edges bending upward to form a crescent shaped cup or cavity into whose opening the rudimentary ovule projects. A longitudinal radial section of a carpel thus far developed, presents a picture closely resembling a partly closed hand with the thumb pointing downward toward the palm, the thumb representing the rudiment of the ovule (fig. 41*a*). At this stage of development the edges of the lamina have not quite organically united, a fact made clear by fig. 41*b* which is a transverse section cut in the plane *x*—*x* of fig. 41*a*.

The initial cell of the embryo-sac is hypodermal. The surrounding hypodermal cells by their behavior seem to be suggestive of a sort of archesporium (figs. 31, 32).

Before the first division it elongates a good deal, and sometimes becomes very broad (fig. 33). In the majority of cases observed only the lower of the two cells resulting from the first division divided again (fig. 38). Sometimes, however, both cells divide as in the preceding genera (fig. 39) though this is less frequent in the genus Ranunculus. In a number of instances the nucleus in the upper cell divided without being followed by the formation of a cell wall (fig. 35), and in others a longitudinal division of this cell took place. From fig. 34 it seems probable that two cells have begun to develop into embryo-sacs. Here only two cells were formed from



NICHOLS on VAUCHERIA.

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each initial cell, the upper being already partly disorganized. The development of the embryo-sac from the mother-cell is perfectly normal. In this species the egg-apparatus is larger at first than the antipodal cells (fig. 40) two of which only are shown in the figure. The latter increase in size, however, with the subsequent growth of the embryo-sac, but as far as observation went, they do not reach the enormous size that obtains in the genera previously mentioned.

Ranunculus recurvatus.—The most striking difference between R. abortivus and R. recurvatus from an histological point of view, is the larger meristematic cells of the latter. In this respect R. recurvatus resembles Delphinium and Caltha. The development of the embryo-sac from the initial cell requires but few additional remarks. Figs. 42 and 43 will make the process clear. Fig. 44 presents a phenomenon probably indicating the tendency of more than one cell to develop into an embryo-sac.

The antipodal cells are large, and increase considerably in size during the subsequent growth of the sac. In one case their position differed from their usual orientation (fig. 45). In one embryo-sac a cleft or cavity seemed to extend some distance downward into the chalaza beneath the antipodal cells, in which could be recognized only a slight trace of a protoplasmic substance (fig. 46). Here the large antipodal cells, rich in protoplasm, and with large nuclei, rest upon the disorganized remains of cells. Another exceptional phenomenon was observed in the presence of a small tracheary and a small tracheid element beneath the antipodal cells (fig. 60). In this figure are shown two antipodal cells of unequal size, one behind the other, with an endosperm nucleus on the right and left, and the above named elements below. As these two phenomena were observed in one case only, I am not inclined to attach any special significance to them at present.

R. septentrionalis.—This species resembles the preceding very closely, especially in regard to the size of its embryonic cells and the behavior of the initial cell, which gives rise sometimes to four cells (fig. 47). Fig. 48 illustrates what frequently takes place in the cells which immediately surround the embryo-sac mother cell and its disorganizing sister cells. The mother-cell in the figure is partly concealed by those on either side.

The mature embryo-sac is perfectly normal; the antipodal cells are large, and increase in volume with the subsequent growth of the embryo-sac.

Anemonella thalictroides.—In an early stage of the ovule of this species there was observed in several instances a number of hypodermal cells well marked off from the cells below, suggesting a primitive archesporium (figs. 49, 50). It is very probable that there is here but one initial cell, as only one was found to proceed in its development, and that the sharp definition of these cells is due to regularity in growth; yet the possibility is not excluded that there is present a tendency of more than one cell to become reproductive. As to the origin of the inner integument at *i—i*, fig. 49, there can be no question. In all ovules examined the number of cells produced by the initial cell was three (fig. 52). The nucellus is rather long and narrow impressing this character upon its cells.

The antipodal end of the gradually enlarging embryo-sac is more or less pointed, and the large antipodal cells adapt themselves to this space. Extending backward through the nucellus from the antipodal end of the newly formed embryo-sac is a strand of long narrow cells resembling the rudiment of a vascular bundle. This strand is gradually absorbed by the encroaching embryo-sac which makes its way wedge-like to the base of the nucellus. The nuclei of the antipodal cells are large and undergo division.

Thalictrum dioicum.—In this genus the development of the embryo-sac agrees closely with that of Anemonella. It is evident (fig. 54) that the great bulk of the nucellus owes its origin to the hypodermal layer of cells. This statement will apply generally to all the preceding genera.

As far as observation extended, the initial cell gives rise to three cells only, but in all probability four occasionally result from two successive divisions, as in the other genera.

The nucellus is less elongated than in Anemonella; the embryo-sac more oval in form and it reaches maturity sooner with reference to the corresponding growth of the integuments. The antipodal cells are large, but not so pronounced as in Anemonella.

Hepatica acutiloba.—The earlier stages in the development of the embryo-sac of Hepatica were not observed, as my material, collected about the middle of November, was too far

advanced for that purpose. The youngest stage observed showed three cells derived from the initial cell, the lower one becoming the mother cell.

The mature embryo-sac of Hepatica is especially interesting. Before fertilization both egg-apparatus and antipodal cells, as well as the cavity of the sac itself, become unusually large. At the upper ends of the synergidæ there appears a number of protoplasmic strands converging to a point and thus forming a star-shaped cap (fig. 55). The egg-cell is broader at its upper end and rather deeply inserted. All three cells of the egg-apparatus are surrounded by very delicate membranes. The antipodal cells increase greatly in size during the subsequent growth of the embryo-sac, and at the time of fertilization each cell may contain as many as ten or a dozen nuclei (fig. 56), due to fragmentation. The process of fragmentation may be readily observed here (fig. 57). Each nucleus contains two or more nuclei situated in spherical or oval vacuoles.

Soon after fertilization, or when the embryo has reached the stage of development shown in fig. 58, the antipodal cells bear evidence of dissolution, the fusion of all the nuclei into a common mass being the preparatory step.

On account of the large nuclei, the cells of the developing embryo and endosperm of Hepatica afford favorable objects for the study of karyokinesis.

I may add here that by staining on the slide with aniline safranine and picric nigrosine I was able to see the centrospheres or what seemed to be centrospheres (fig. 69). The centrosomes appeared as extremely small dark points surrounded by a colorless court, and the radiating kinoplasmic zone was also darker but difficult to see.

In some instances I have observed what were taken to be centrospheres at the poles of nuclear spindles (fig. 4, upper end of spindle) in preparations that were not subjected to the special process said to be necessary to demonstrate these structures.

Summary.—This work has been interesting especially as a study in variation. That which first of all attracts our attention is found in the presence of more than one initial cell and their development into normal embryo-sacs. In the genera under consideration the number of initial cells reaches its culmination in Caltha where five or more may be present

in the ovule, suggesting a sporangium which indeed it is, for the ovule certainly stands for a macrosporangium with its integumentary covering or indusium. Although the presence of more than one embryo-sac in an ovule has been observed by several investigators in widely separated families, yet further research will undoubtedly show the phenomenon to be still more prevalent and widely distributed. Just how far this fact will throw light upon the origin of the angiosperms remains yet to be seen, but it certainly contributes materially to the phylogeny of the seed plants.

The production of a series of four cells by two successive divisions of the initial cell of the embryo-sac, occurs more frequently in this family than had hitherto been supposed; and it seems probable that a more extended search in those genera in which this phenomenon was not observed by myself would reveal its occasional presence.

In connection with the foregoing facts several questions naturally arise upon which it is not my purpose to speculate at present. What is the significance of the fact that in the same species the initial cell gives rise sometimes to only three cells and sometimes to four? Is the behavior of the initial cell due to inherent tendencies alone, or is it determined partly by external forces? Which is the more primitive condition, that represented by the series of three or of four cells?

If the small cell cut off occasionally from the initial cell in Aquilegia be regarded as a tapetum, we certainly have here an isolated phenomenon occurring where it would not be generally expected. Guignard[10] has observed the presence of a tapetum in certain genera of a family while in other genera of the same family a tapetum was absent; but no other instance is now known to me in which a tapetum was only of occasional occurrence in the same species.

The rule so general in its application among angiosperms, that the lower cell of the series derived from the initial cell develops directly into the embryo-sac, seems to have a probable exception in Caltha (fig. 16). Guignard speaks also of a probable exception in *Acacia albida*, and in the same place refers to a case reported by Mellink in one of the monocotyledons (Agraphis), together with the analogous case described by Strasburger for *Rosa livida*.[11]

[10] Embryogénie des Legumineuses. Ann. des Sc. Nat. Bot. VI. **12**: ——.

[11] l. c., p. 137.

In regard to the large cells of the ovule in such species as Caltha palustris, Ranunculus septentrionalis and Delphinium tricorne and the comparatively small cells of Aquilegia, it seems that we have a phenomenon which may be correlated with the habitat of the plant. In the marsh dwelling Caltha we find the largest cells, followed in order by Ranunculus septentrionalis, R. recurvatus which thrive better in moist soil; then come Delphinium, Hepatica and R. abortivus which flourish in a drier soil. On the other hand Anemonella, Thalictrum, and especially Aquilegia, whose cells are very small, are particularly dry soil plants. This is not given as a theory or explanation, but merely as a suggestion, for I do not know how far the facts in different genera and species of other families contribute to the support of such a view or whether they contradict it.

Besides the Ranunculaceæ, unusually large antipodal cells have been observed in *Delphinium villosum*,[12] *Ornithogalum nutans*, *Gladiolus communis* and *Crocus*. I have also observed large antipodal cells in *Jeffersonia diphylla*.

As to the large antipodal cells, which with their numerous nuclei become so rich in protoplasm, it may be said in harmony with known facts, that they have passed from a formative into a nutritive condition which we find paralleled in the internodal cells of Chara and Nitella.[13]

Bloomington, Ind.

Explanation of Plates XVII–XX.

Figs. 1–10, Delphinium.

Figs. 1 and 2. Median longitudinal sections of very young ovule. × 335. In fig. 1 two initial cells can be seen; in fig. 2, only one, which is larger than the other hypodermal cells.—Fig. 3. Similar section of an older ovule with two large initial cells. × 335. The anatropy of the ovule is more pronounced.

Figs. 4–8. Median longitudinal sections of the nucellus. Fig. 4. The nucleus of the large initial cell of the embryo-sac is in the spindle stage of division; at the upper pole are centrospheres. × 335.—Fig. 5. The initial cell has divided transversely, the lower cell being larger. × 335.—Fig. 6. The lower cell has already divided; the upper is in process of division. × 335.—Fig. 7. Two initial cells in process of development. In the cell on the right, the nucleus is dividing; the one on the left shows the lower cell in process of division. × 335.—Fig. 8. The lower cell of the series, the embryo-sac-mother-cell, has en-

[12] Strasburger, Ueber Befruchtung und Zelltheilung, 38, 41. 1878.
[13] Strasburger, Histologische Beiträge, 5: 99, 100, etc. 1893.

larged considerably; the three cells of the series above are disorganized. × 335.

Fig. 9. Two mature embryo-sacs lying side by side in the same ovule. × 260.—Fig. 10, *a* and *b*. The egg-apparatus and antipodal cells respectively drawn from the same embryo-sac. Only one synergida is shown, the other lies beneath. Above the antipodal cells, of which two are drawn, lies the large endosperm nucleus. × 335.

Figs. 11–19, Caltha.

Figs. 11 to 18. Median longitudinal sections of young ovules.

Fig. 11. Three large initial cells stand side by side in the plane of the section. Some of the epidermal cells above them have divided by periclinal walls. × 335.—Fig. 12. Probably a group of four or five initial cells; a space is seen between the two on the left. × 335.—Fig. 13. The initial cell has divided, and the nucleus of the lower cell is in the skein stage preparatory to division. × 335.—Fig. 14. Three cells have been derived from the initial cell. The mother-cell already slightly enlarged is separated above by a swollen wall. ×335.—Fig. 15. Two cells have been formed from the initial cell; the two nuclei in the lower are separated by two large vacuoles. × 335.—Fig. 16. Of the three cells derived from the initial cell the two upper are larger; the lower cell seems partly crowded out; the inner integument has just appeared. × 335.—Fig. 17. The mother-cell has apparently displaced the two cells above it. The epidermis of the nucellus has formed a layer three or four cells thick. × 335.—Fig. 18. Embryo-sac with two nuclei in each end. × 335.

Fig. 19. In the upper cell formed by the first division of the initial cell two nuclei are shown in outline. × 335.

Figs. 20–30. Aquilegia.

Figs. 20–28. Median logitudinal sections of the nucellus.

Fig. 20. A small cell has been cut off from the initial cell. ×465.—Fig. 21. Similar to Fig. 20; the nucleus of the larger cell is in division. × 465.—Fig. 22. One step beyond fig. 21; in the two cells below the small tapetal (?) cell, the nuclei are in division. ×465.—Fig. 23. Only the usual four cells have been produced by the initial cell. ×465.—Fig. 24. Same as fig. 23, the mother cell having enlarged. × 465.—Fig. 25. The initial cell has given rise to five cells. × 465.—Fig. 26. The terminal cell of the series has divided almost at right angles to the usual plane of division. × 465.—Fig. 27. The enlarging mother cell with the remains of the sister cells above; a large vacuole occupies the upper half of the mother-cell. × 465.—Fig. 28. Similar to fig. 27, but the nucellus is narrower; the vacuole occupies the lower half of the cell. × 465.

Fig. 29. An embryo-sac shortly after maturity. The nucellar cap is only two cells thick. × 335.

Fig. 30, *a* and *b*. A young embryo with the remains of one of the synergidæ and two enormous antipodal cells drawn from the same embryo-sac. Two nuclei are present in the cell on the left; vacuoles are indicated by dotted lines. × 260.

Figs. 31–41. Ranunculus abortivus.

Figs. 31–38. Median longitudinal sections of the ovule.

Fig. 31. The initial cell is distinguishable by its larger size. × 335.—Fig. 32. The initial has increased greatly in length; the cell of the axial row of the nucellus, just below it failed to divide, and as a result is larger than its neighbors. × 335.—Fig. 33. The nucleus of the unusually broad initial cell is in division. × 335.—Fig. 34. Two initial cells that have each given rise to two cells which are apparently mother-cells. One mother-cell is partly hidden by the other. × 335.—Fig. 35. Three cells have resulted from the initial cell, the nucleus in the upper one has divided. × 335.—Figs. 36 and 37. Similar to fig. 35. In fig. 36, the uppermost cell has divided longitudinally. In 37, the two nuclei in this cell lie side by side in a vertical plane. × 335.—Fig. 38. The mother-cell has begun to encroach upon the cells above. × 335.

Fig. 39. Four cells have evidently been produced from the initial cell. The disorganizing cells above the large mother cell have greatly swollen walls. × 335.

Fig. 40. Mature embryo-sac, together with the surrounding tissue of the nucellus. Only two antipodals and two cells of the egg-apparatus are drawn. × 260.

Fig. 41, *a* and *b*. *a*, *a* longitudinal radial section through an immature carpophyll; *b*, a transverse section made in the line *x*—*x*. × 85.

Figs. 42–46, 60, Ranunculus recurvatus.

Fig. 42. Median radial longitudinal section of a rudimentary ovule. The nucleus of the initial cell is drawn in outline. × 335.

Figs. 43 and 44. Median longitudinal sections of the nucellus. In fig. 43, four cells would have resulted from the initial cell, the division of the upper cell is almost complete, when the wall would have been oblique. In fig. 44, three cells have resulted from the initial cell (on the right), and if two initials were present here, four cells (on the left) would have been the descendants of the same. × 335.

Fig. 45. Three antipodal cells, with an unusual orientation.

Fig. 46. A vertical section through a portion of the chalaza. Two antipodal cells rest upon fragments of disorganized cells, and below them a narrow cavity extends a short distance downward into the chalaza. This figure was taken from an embryo-sac that had increased greatly in size after having been laid down. × 335.

Fig. 60. Two antipodal cells, below which are two small tracheary elements: on the right and left may be seen a nucleus of the endosperm. × 335.

Figs. 47, 48, Ranunculus septentrionalis.

Fig. 47. Longitudinal section of nucellus. Four cells have been formed from the initial cell; the upper one has divided obliquely. × 335.

Fig. 48. The enlarging mother cell is partly hidden by the lateral, turgid cells. × 335.

Figs. 49–52. Anemonella.

Figs. 49, 50. Longitudinal section of the ovular rudiment. Several hypodermal cells with nuclei indicated are very sharply defined from the cells beneath. The origin of the inner integument is shown at *i, i.* In Fig. 50 the hypodermal cells are equally well defined; the initial cell is probably the middle one of those in which the nuclei are outlined. × 335.

Figs. 51, 52. Longitudinal sections of the nucellus.

Fig. 51. The nucleus of the initial cell is in process of division. × 335.—Fig. 52. Three cells have been derived from the initial cell; the mother-cell has somewhat enlarged. The nucellus is long and narrow. × 335.

Figs. 53–54. Thalictrum.

Fig. 53. Longitudinal section of young ovule. The initial cell is very large, reaching almost the entire length of the nucellus. This figure plainly shows that the bulk of the nucellus, aside from the epidermis, owes its origin to the hypodermal layer of cells. × 335.

Fig. 54. Three cells owe their origin to the initial cell. × 335.

Figs. 55–59. Hepatica.

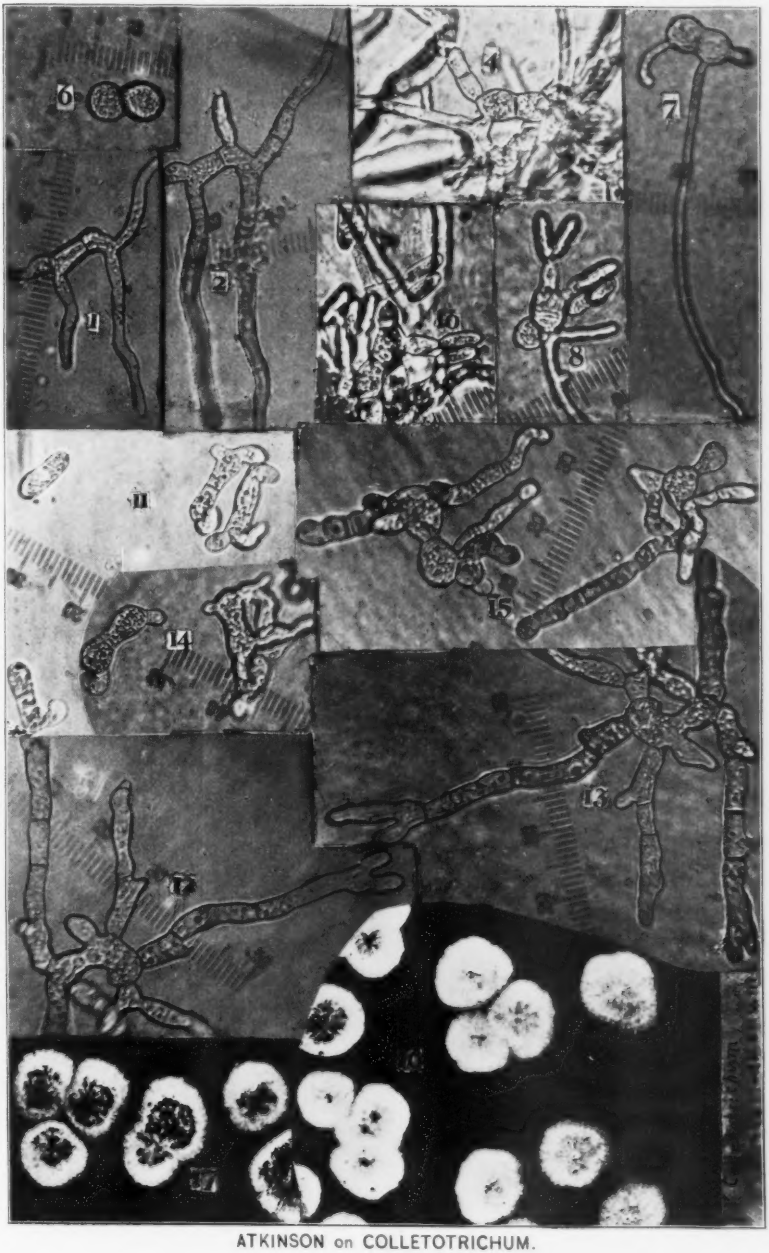
Fig. 55. Egg-apparatus with the nucellar cap above. At the upper ends of the synergidæ is a star-shaped protoplasmic mass. × 260.

Fig. 56. An antipodal cell with eleven nuclei due to fragmentation. × 260.

Fig. 57. Two nuclei from an antipodal cell in process of fragmentation. × 335.

Fig. 58. A four-celled embryo. The wall separating the lower end cells lies almost in the plane of the paper. The nucleus indicated by dotted line could be seen by focusing down. × 335.

Fig. 59. Nucleus with two centrospheres at the right. × 675.



ATKINSON on COLLETOTRICHUM.

Some observations on the development of Colletotrichum lindemuthianum in artificial cultures.

GEO. F. ATKINSON.

WITH PLATE XXII.

Several times during the summer of 1893 I attempted to obtain a pure culture of the bean anthracnose for the purpose of noting its behavior in artificial media. Dilution cultures were attempted in the ordinary agar-agar peptone broth, from material recently collected but which had dried. None of the spores germinated. Thinking that the nutrient agar might be an unfavorable medium for their growth, cell cultures were started in water to test the vitality of the spores. The spores here likewise failed to germinate for me. This seemed surprising, for related forms of *Glœosporium* and *Colletotrichum* of quite a number of species have never failed to germinate promptly even after several months drying.

Some of the material from which the attempts were first made was used in the dilutions within three days after picking the fresh pods of the bean, which contained the spores of the fungus in great numbers, and they had not been dry for more than twenty-four hours. Still they failed to germinate for me. Several other attempts were made during the autumn of the same year with like failures.

During February of the following year, 1894, preparations were made for another attempt at obtaining a pure culture of the fungus. Since the fungus is perennial in matured beans which are affected, it was planned to obtain diseased but mature and dry beans, and then grow them in order to obtain in the laboratory freshly developed spores. Accordingly requests were made from several leading seedsmen for badly anthracnosed beans for the purpose of obtaining material for cultures. Some very fine specimens were received of what is known as Wardwell's kidney wax. The beans presented an unsightly appearance, being stained various shades of yellow and fuliginous, some of them also possessing depressed spots where the fungus was more deeply seated. In one specimen which presented nearly one entire side in a badly diseased condition, there were also several pustules which appeared

as if spores were present in a dormant condition. This bean was placed in a moist chamber to induce the fresh development of spores. March 7, 1894 (a few days later), the pustules were considerably larger and the material was examined. Fresh spores were present in great numbers and dilution cultures for the separation of the fungus were started on the same day. The room temperature was rather low, and on the following day none of the spores had germinated though some which were seen had swollen to some extent and refringent granules were appearing. Culture number one was then left in a warmer room and on the following day the spores were germinating and their study in this condition was then made. The germ tubes are very large, equalling or even in some cases exceeding the diameter of the spore. The first tubes usually arise near the ends of the spore and are generally directed at a greater or less angle from the axial line of the spore. The refringent granules are quite numerous and large so that the protoplasm presents a very coarsely granular appearance. In the homogeneous protoplasm vacuoles also soon appear but they are at first quite indistinct. The threads for a short distance from the spore describe a sinuous course and branch in an irregularly monopodial fashion, at the same time other threads arise from the spore so that a small radiating colony is soon developed. Quite soon however on the margin of the small colony the threads frequently present a dichotomous appearance. This in some cases is brought about by a perfect dichotomy of the thread but very frequently and perhaps in a majority of cases there arises a branch just behind the growing end of the thread which very soon overtakes the primary thread, and the influence of its origin so close to the end of the thread causes the growing end of the same to be diverted so that the appearance of dichotomy is the result. On the very young colony only a few of the threads on the margin present this appearance, but soon all of the threads partake in this dichotomous branching and very frequently it occurs successively in rapid sequence on the same thread, so that a plumose or brush shaped tuft is produced. The various branches of this tuft lie nearly parallel and quite close together. At this time and indeed very soon after germination the vacuoles in the protoplasm become quite large and prominent. Also at the ends on the plumose branches very short lateral branches now

arise, several on one side, and the end of the thread is frequently curved to the same side. Upon these short branches are developed the dark bodies which appear in certain of the anthracnoses sometimes called secondary spores.

On March 10th from dilution culture no. 2 small colonies of the fungus were transplanted to vetch stems in culture tubes for pure cultures. In two days a very minute growth appeared at the points of the transplantings as fine radiating white threads. In a few days more the spots of the central point of growth became black by the darkening of the threads while the advancing margin of the weft continued white. On the 14th spores were found to be developing in considerable numbers. By the 16th areas varying from 1 to 2^{cm} in length on the stems were occupied by the very black and thin stroma of the fungus. Except where the threads had reached the liquid in the bottom of the culture tube there was no considerable development of white fungus threads. In the liquid however quite a profuse growth took place. From the surface of the dark stroma in some cases a scanty growth of whitish threads arose for a few millimeters from the surface. The dark stroma itself was roughened by the development of irregular tuberculate prominences.

April 20th pure dilution cultures were started to obtain the spores in different stages for the study of germination and the following development stages, more especially that these might be recorded in photomicrographs while the organisms were *in situ*.

The dilutions were made in Petri dishes. On the following day, the 21st, the cultures were examined and no spores were found germinating, though they were present in numbers and there was no difficulty experienced in finding them in the cultures.

The cultures were examined again on the 22nd, and while the spores did not appear as if they were dead there were none germinating. On the 23d a few of the spores were found to be germinating.

On the 24th at 5 P. M. additional cultures were made in Van Tieghem cells in the following way. The cells were prepared and the cover glasses sterilized by passing several times through the flame and then placed under a bell jar to protect them from gravitating germs while the culture material was being placed on them. In order to have a large number of

spores in a small space about one-half cc. of liquid agar was prepared in culture tubes and these inoculated by transplanting a considerable quantity of the mycelium and attached spores from the culture on vetch stems. This would probably assure a large number of spores in the liquid. With a looped sterilized platinum needle a small quantity of the inoculated liquid was lifted from the tube and allowed to spread upon the center of the cover glass, only one transfer being made, and the liquid thus was held in a thin layer until solidification took place. Many of the spores were thus in close contact with the glass, and in germination would be nearly in the same plane.

During the afternoon of the following day the spores began germinating in the cell culture and one of the spores with four germ tubes was photographed (fig. 1). This same spore was photographed on the following day, twenty hours later, and is shown in fig. 2. In all cases unless the spore is very short and nearly oval a septum appears at the time of germination, forming two cells, and at the point of the septum the spore becomes constricted even soon after germinating. The cell culture now became contaminated with bacteria and further growth was impossible. Even at the time of photographing no. 2 the bacteria at this place were quite numerous, and the flocculent matter which clouds one portion of a thread and the margins of others is a mass of bacteria (fig. 2).

The cultures in the Petri dishes were now examined again, dilution no. 1 first. A few colonies were visible to the unaided eye as irregular stellate patches. This examination showed that the spores after germination had continued to increase in size for some time so that they became several times larger than when germination first takes place. One of these was photographed with a magnification of about 500 diameters (fig. 4). With this magnification only the central portion of the colony could be shown. The threads radiating from the spore turn in various directions so that it is not possible to bring them all in the same focal plane. The spore was the point which was focussed upon and a few of the threads are in the same focal plane and show the proportionate diameter, the septation and size of the cells. At this time the highly refringent granules which appear at the time of the germination of the spore and are then comparatively

small, are now much larger and quite strongly differentiated from the hyaline contents. They are quite numerous in the enlarged spore and are also present to a less degree in the threads.

At the same time it was observed that the very large majority of spores in the same culture, which had failed to germinate at the time the first ones germinated, had continued to increase in size, were once septate, strongly constricted at the point of the septum and were richly charged with large highly refringent granules. It fact but for the germination of the first spores there could not be determined any difference. One of these is shown at fig. 6. The margin was a trifle out of the focal plane so that the wall presents a heavier line than should be the case. In culture dilution no. 1 none of these spores germinated, but in culture dilution no. 2 nearly all of them began germinating on the 25th and on the 26th several of these were photographed to show the different results which follow. Fig. 7 shows one with only the ordinary germ tubes, fig. 8 is developing basidia directly from the spore and bearing several spores, others had but few germ tubes terminated by the oval, dark bodies. It thus seems that these spores which do not readily at first germinate become for a short time places for the storage of reserve material, and later germinate. Whether they would under conditions giving an abundance of room produce colonies like the first ones has not been determined, for in the present culture they were too close together for this result.

In plate culture no. 2 the older and stellate colonies developed a compact stroma at the center which bore numerous spores with a slight roseate or flesh colored tinge. On April 28th four cultures on sterilized bean stems were made of this dilution culture in order to study the behavior of these normally developed spores in comparison with those which were late in germinating and did not develop in this culture many spores. Two of these cultures on bean stems were made by transplanting spores from the normally developed colonies, and two were made by transplanting some of the agar containing the second type of spores which were late in germinating.

May 7th a culture, using numerous spores, was made in a Petri dish during the afternoon. This culture was made by pouring a small quantity of agar containing numerous spores

over the surface of previously solidified agar in the plate, thus securing numbers of spores in a thin plane at the surface of the medium. On the following morning eighteen hours after sowing, the culture was examined and many of the spores were found to be germinating, the temperature being quite favorable to quick germination for this species. One group of spores was selected for a photomicrograph (fig. 11), containing three spores with young germ tubes and two spores not yet germinated. One of the spores germinating shows plainly the division of the spore into two cells at the time. Twenty-four hours later considerable growth had taken place. The preceding day when the first photomicrograph was taken, a cover glass was placed over a portion of the culture in order to prevent the moisture from the surface of the agar from condensing on the objective when the strong reflected rays of the sun should be mirrored through the culture during the exposure.

From former experiences it was found that very little growth was made after having once shut out the access of oxygen by placing a cover glass over a number of the spores. In this case the growth was surprising for it was quite considerable, though not so much as that of spores not thus covered. Perhaps this considerable growth compared with the very little or none in other experiences was due to the peculiar way in which this culture was made. A photomicrograph of the growth of one spore was made at this time (forty-two hours after sowing) and is shown in fig. 12. The spore itself at the center of the colony can be seen from its greater diameter than that of any of the threads. It is also quite strongly constricted at the center which is brought about by the rapid enlargement or swelling of the spore. In order to bring certain of the threads into strong focus which it was desired to reproduce with their characteristic features in detail the spore was thrown slightly out of focal plane, and the septum in the spore is not well seen and the vacuoles not distinct. In certain of the threads however the vacuoles and septa are distinctly shown. The peculiar dichotomous branching of the hypha which frequently occurs in this species is shown in two of the threads. A photograph taken three hours later of this same colony is represented in fig. 13. In one of the dichotomous divisions one fork has considerably outgrown the other. The growth of the spores which were not covered by the cover

glass was by this time considerably in advance of that of the ones used to illustrate these features. In this culture as well as in those previously studied, many of the spores did not germinate at first, but manifested their activity by absorbing nutrient material and assimilating it from the medium, thus increasing in size and in the richness of the granules. This is also accompanied by the formation of the cross wall making two cells in most cases and also in a greater or lesser constriction of the spore at the middle. These spores begin to germinate at varying intervals so that the process of germination is going on for several days or even for a week. Forty-eight hours after sowing the spores, two of them having recently germinated were photographed (fig. 14). One spore possesses two very short germ tubes, one at each end; the other spore which was slightly out of the focal plane has not only a germ tube from each end but some from the side as well, and all but one of the threads are quite long and flexuous. Sixty-six hours after sowing two other spores were photographed (fig. 15). Here the spores are of considerable size, a result of the continuous swelling, and the septum at the strongly constricted central portion can easily be seen.

Cornell University.

Explanation of Plate XXII.

Figures 1 to 15 are photomicrographs of the living organism in the nutrient agar where it was growing. The objects were therefore unstained.

In figures 16 and 17 are represented, natural size, the form of the mature colonies of two plate cultures.

On the validity of some fossil species of Liriodendron.

THEO. HOLM.

WITH PLATE XXIII.

The making of species of fossil plants has been increasing rapidly during the last few years, and many new species have been recorded from this country. It seems, however, when we study the various articles that have been published upon the subject, as though there were a rivalry to see who could establish the largest possible number of species. Whether or not this is true, American paleobotanists are certainly going too far in giving incomplete and insignificant leaf-fragments specific names. Any botanist who studies our existing flora can not avoid observing the great variation that exists in the foliage of our trees and herbs; and must admit that it would be very difficult to refer all these leaf-forms to their respective species if they had been detached from their branches. Another fact that makes the study of paleobotany still more difficult is the usual absence of flowers and fruits. The identification of even the most completely preserved leaf must, therefore, be more or less uncertain, and when we consider fragments of such leaves, which do not show anything but a few veins and no very pronounced outline, we can only say that the identification becomes a mere guess, not only wholly worthless for scientific purposes, but often very misleading.

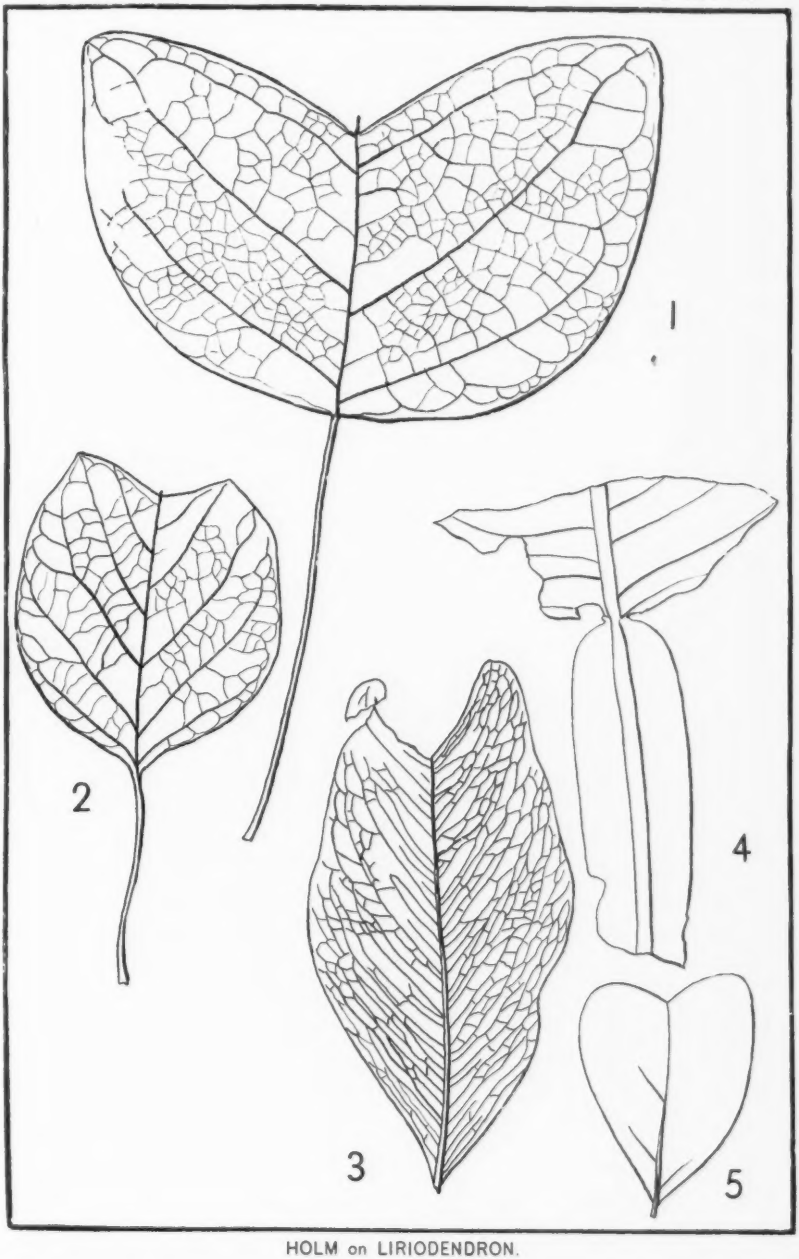
A careful study of the recent flora is, therefore, absolutely necessary, when it is desired to identify fossil leaves with even an approximate degree of correctness. The plant must be studied as it stands amidst the surroundings to which it has adapted itself, and which its leaves reflect, as we have learned from the excellent illustrations by Sachs[1], Wiesner[2], and Stahl[3].

But it would really seem as if our paleobotanists ignore these facts, and consider their fossil leaves only as dead matter

[1]Sachs, Julius: Die Anisotropie der Pflanzenorgane. Vorlesungen über Pflanzen-Physiologie 855. 1882.

[2]Wiesner, Jul.: Untersuchungen über den Einfluss der Lage auf die Gestalt der Pflanzenorgane. Sitzungsber. d. kais. Akad. d. Wiss., math.-naturw. Classe **101:** 657–705. 1892.

[3]Stahl, E.: Regenfall und Blattgestalt, ein Beitrag zur Pflanzenbiologie. Ann. du Jardin Botan. de Buitenzorg **11:** 98–182. 1893.



HOLM on LIRIODENDRON.

THE
JOHN CHEDA

without signs of ever having lived. Some peculiar species have been made in this way, and it is our intention to give a few illustrations of supposed relationships existing between some fossil forms and the living species of our tulip-tree.

One of the most striking characters of the Liriodendron leaf is of course the notched apex in connection with the broad, more or less deeply lobed blade. We have already shown[4] that leaves of seedlings and those at the base and apex of branches of mature trees are often oblong or obcordate without any lobation, and yet they still possess the characteristic notch at the apex. This last form, the approximately obcordate, reminds one very much of the leaflets of certain Leguminosæ, and such leaves, when found in a fossil state, are generally referred to *Leguminosites* or to *Liriodendron.* With very few exceptions we believe that such forms do not belong to Liriodendron, at least if we compare the illustrations given of the fossils with the leaves of our recent species. Mr. Arthur Hollick in a recent paper[5] figures and describes several oblong leaves with notched apices as representing *Liriodendron simplex* Newb. Some of these leaves are very well preserved and show the outline and venation very distinctly, so distinctly in fact, that it may easily be seen that they are very different from leaves of Liriodendron as we understand the genus from the living species. We have copied one of Mr. Hollick's figures on the accompanying plate XXIII, fig. 3, and we have added two forms of similar small leaves of our living species for comparison (figs. 1 and 2.). Considering the mere outline of the leaves here brought together, we notice at once the disproportionate length of the fossil species, and the open sinus or notch at the apex of the recent form in connection with its long and slender petiole. It is not known whether the fossil leaves had any petiole; they appear rather to have been nearly sessile. The venation also is different, the living showing but few secondary veins, the fossil on the contrary numerous ones which together with the tertiary veins form a reticulate venation. So far therefore these fossil leaves show no evidence whatever of any relationship to the genus Liriodendron.

[4]Holm, Theodor: Notes on the leaves of Liriodendron. Proceedings U. S. National Museum **13:** 15–35. *pl. 4–9.* 1890.

[5]Hollick, Arthur: Preliminary contribution to our knowledge of the Cretaceous formation on Long Island and eastward. Transact. New York Acad. Sci. **12:** 222–237. *pl. 5–7.* 1893.

We have stated above that such unlobed, notched leaves in many cases remind us of the leaflets of several Leguminosæ, and if we compare Mr. Hollick's figure 2 on his plate V (l. c.) where three leaves of the same size, shape and venation as our fig. 3, which is one of them, are figured, might we then not assume that they have been situated close together as they were found in the rock? They seem indeed to have formed a *trifoliate leaf*, not unlike Desmodium, Phaseolus, and others. Their venation is much more like that of the Leguminosæ than of any known Liriodendron. Moreover we must not forget that notched leaves are not only common among the Leguminosæ, but exist in many genera of various families, e. g., Zygophyllum, Passiflora, Akebia, etc., which might also be taken into consideration.

We see from this comparison that it is very unsafe to refer such leaves to Liriodendron, when such essential points as the petiole and the venation are imperfect or wanting. It is furthermore difficult to understand how Mr. Hollick could find any probable relationship between the small fragments figured on his plate 179[6], and the genus Liriodendron. These fragments might just as well have been referred to genera of entirely different families and if not, we do not see why his leaf of Colutea (l. c.) figured on our plate as no. 5, has not been identified as a Liriodendron or Liriophyllum, in accordance with the other species mentioned above.

There is now another point to which we should like to call attention, viz., what Mr. Hollick calls the wing-like appendages on the petioles of *Liriodendron "alatum."*[7] It seems to be taken for granted that this fossil form is also a representative of our tulip tree. Mr. Hollick's drawings are so large that we have only had space enough to figure one of these fragments, fig. 4, on our plate XXIII. He figures one nearly complete leaf with a wide notch at the apex and a winged petiole. Also the base of a blade with a similarly winged petiole (figured on our plate) and finally the upper part of a blade with a very narrow notch, unlike that of a typical leaf of Liriodendron. The winged petiole appears to have been no obstruction to Mr. Hollick's identification, the notched

[6] Hollick, Arthur: Additions to the paleobotany of the Cretaceous formation on Long Island. Bull. Torrey Bot. Club **21:** 49–65. *pl. 174–180.* 1894.

[7] Hollick, Arthur: Wing-like appendages on the petioles of *Liriophyllum populoides* Lesq., and *Liriodendron alatum* Newb., with description of the latter. Bull. Torrey Bot. Club **21:** 467–471. *pl. 220–221.* 1894.

apex eliminating all doubt of kinship in spite of the fact that the venation does not agree with that of our type. This species, *L. alatum*, was described by Dr. Newberry, but not published. Mr. Hollick in accepting the identification considers it from the point of view of a modern evolutionist. He sees nothing wrong in attributing adnate stipules to this genus; on the contrary he claims it to be a leaf-form "exceedingly interesting and significant." Taking "the standpoint of the evolutionist" he compares the leaf with *Platanus basilobata*, figured and named by Professor Lester F. Ward.[8]

The fact that Liriodendron and Platanus are genera with entirely different biological peculiarities is overlooked. Mr. Hollick even goes so far as to state that "it is reasonable to attribute similar origin to the conspicuous but fugacious stipules on the young saplings and shoots of Liriodendron." It would appear that Mr. Hollick does not know that the stipules are free in all the leaves of our tulip-tree, not only on the saplings but on all the branches from seedlings to mature trees. And this view, says Mr. Hollick, is "of course greatly strengthened by the discovery of the fossil species now under consideration." Professor Ward has figured some leaf-fragments of a supposed Platanus, and he compares these with our recent species, *P. occidentalis*, in which a basal lobation of the blade may sometimes be observed. But we have no proof whatever that these fragments of *Platanus basilobata* really belonged to any true Platanus, and Nathorst,[9] one of the ablest of European paleobotanists, considers their identification as incorrect. The French botanist Godron[10] and later Sir John Lubbock[11] have described the stipules of Liriodendron and explained how the leaf becomes notched. Godron figures the shape of the leaf while still enclosed in the bud, the bud scales being the stipules themselves. The entire leaf bends over when it is in bud, and the notch is the result of the fact that the apex of the blade rests in a furrow formed by the axis and one of the stipules.

Any one who has studied vernation in its various forms will

[8] Ward, Lester F.: The paleontologic history of the genus *Platanus*. Proceed. U. S. National Museum **11**: 39-42. *pl. 17-22*. 1888.

[9] Nathorst, A. G.: Review of "Types of the Laramie Flora by Lester F. Ward." Neues Jahrbuch für Mineralogie **2**: 219-222. 1893.

[10] Godron, A.: Observations sur les bourgeons et sur les feuilles du Liriodendron Tulipifera. Bull. de la Soc. Bot. de France **8**: —. 1861.

[11] Lubbock, Sir John: Phytobiological observations. Journ. Linn. Soc. **22** and **24**: —. 1887.

appreciate the fact that the Liriodendron leaf could not possibly assume the position it does in the bud if the stipules were not free. If we now consider Mr. Hollick's figure of *L. alatum*, it is easily understood that this leaf could not show such vernation as our tulip-tree. The winged petiole would not allow any considerable curvature and the leaf-blade would meet no obstacle to the development of its apex. The notch of this leaf, *L. alatum*, if it is natural and not due to accidental injury or defective preservation, must depend on entirely different causes. It may be for the same reason that so many leaves have a more or less emarginate apex. Why this is we can not explain. One thing is evident, however, that Mr. Hollick's explanation is altogether too superficial to convince one that the ancestors of the tulip-tree had adnate stipules. If we consider his leaves as belonging to Liriodendron, we must suppose the apex to have been acute, that the notch was not natural to the leaf, and finally that the venation was entirely different from our recent type. We must express the same opinion as to Mr. Hollick's comparison of *Liriodendron alatum* with *Liriophyllum populoides*, viz.: that they were closely related on account of their adnate stipules and notched apex. It may be so, but to say the least the chances are quite as strong the other way, and in all probability none of these leaves have ever had anything to do with ancestral forms of Liriodendron.

Washington, D. C.

Explanation of Plate XXIII.

Figs. 1 and 2. Leaves of *Liriodendron Tulipifera* drawn from nature, natural size. — Fig. 3. *Liriodendron simplex* Newb. (copied).— Fig. 4. *Liriodendron alatum* Newb. (copied).—Fig. 5. *Colutea primordialis* Heer (copied).

The nomenclature question.

Botanical nomenclature and non-systematists.

In the discussions on nomenclature, an important phase which receives scant consideration is the attitude of the non-systematists towards it. This is natural enough in this country since nearly all American botanists are systematists, a condition which is due of course to the influence of Dr. Gray. Although he left few or, as some would say, no pupils, he nevertheless, by his pre-eminence and authority at home and abroad, by his attractive personality, and by his splendid works, set systematic botany as the ideal to the students of this country. No teacher or investigator of any thing like equal prominence has arisen among us in any other department of botany, the morphology of cryptogams alone excepted, so that his influence in this particular has hardly yet been weakened.

But the day of systematic botany of the old fashioned based-upon-anatomy sort is passing away. It is exhausting its own field; the law of diminishing return applies to it; and most important of all, the science is outgrowing it. A few of our younger systematists are interested equally in biology; young men, influenced it is true from Europe, are arising among us ambitious to become biologists in the same true sense as zoologists are; and they will change the complexion of botanical work for the next generation.

Now what will be the attitude of the biologists, of the new systematists, of the interested public, in nomenclature? In other words, upon what principle will future users of plant names use them? Now for my own part from what I know of human nature, and from what I have seen and heard among those to whom what a living plant is and does is of more interest than what it resembles or what is said about it in books, I am convinced that the future users of plant names utterly regardless of systems will use them exactly on the same principle as they use other names, simply as conveniences. What then makes a name convenient? Undoubtedly its first quality is ready intelligibility, which depends upon its use by the most people, and as Dr. Robinson has

said, this is more important than stability or consistency. This is simply the law which governs the persistence of all other names. By what divine or other right is botanical different from other language? We must admit that in the long run, where there is no personal or philological reason for keeping to a special system, the principles controlling the use of other names will control the use of botanical names also. But all other names, those of things, places, people, battles, institutions, are, except to philologists, mere symbols or handles. Nobody except the philologists ever trouble to enquire whether they are appropriate, or historically correct or give due honor to their first users or fit a system of orthography or grammar. There are principles governing their giving and use, it is true, but these are never statutory, they are unwritten, unconscious, psychological. Nearly all attempts to legislate on names fail, as witness efforts at orthographical reform of English, of grammarians to control certain features of language, of rulers to replace native names of rivers, etc., by introduced ones. Regulations unaccompanied by a power to enforce them, always fail. In language, names however given, after they have once come into use, are upon the principle of least resistance, used still more because they are the most intelligible. Men use those most convenient at the moment without regard to reasons. Botanical names differ from others only in that they are given with more deliberation and some attempt at system; I am unable to see any principle in their use which will in the long run make them different from other names. I believe, therefore, that all efforts to reform nomenclature which involve changes of well known and well established names, will ultimately fail, for the very good reason that the make-up of men's minds is against the success of such changes.

Another feature of language which the reformers forget is the immense value of authority upon hero-worshiping mankind. It is in all language the use of words by great men which makes these words good form; considerations of consistency and stability are as nothing in comparison. This is very illogical and inconsiderate of humanity, but it is true. The personal nomenclature system of Dr. Gray is to most people made as authoritative by his very use of it, as is the use of English words by a recognized master of English. And why not? Who is better competent to judge of what consti-

tutes a good name? The only man who can attempt with any hope of success to reform Dr. Gray's nomenclature is one who is greater than he and can overcome the weight of his authority by a yet greater, and none such has yet attempted it. If the American botanists would but recognize this principle, and get over their soreness on the point of Dr. Gray's personal system, there would soon be sufficient stability in nomenclature.

In other affairs of life a reform to have hope of success must proceed by building upon whatever already exists that is fixed and good. A reformer who wishes to reform by upsetting everything, good and bad, and beginning all over again upon a plan of his own, is called an anarchist, and the sentiment of the community is against him. A system of reform of nomenclature which would abandon the most fixed names if they do not fit its rules, savors of this spirit. We are told, however, that the proposed system has been tried by other sciences and is a success. But I am inclined to suspect either that the blessed peace which we are assured broods over the camp of the ornithologists, ichthyologists, herpetologists, *et al.*, is not so perfect as it seems, or else that the conditions there are somewhat different from ours.

The solution of the difficulty seems to me to lie primarily in treating nomenclature on the known principles of persistence of language as far as these go, accepting what is fixed as final, endeavoring to settle doubtful cases by following the best usage, and by trying through congresses, etc., to frame uniform rules for the future. This would give us a system which, if not consistent or at first stable, would be convenient and certain to be successful.

The real trouble, I believe, lies in the virtual exhaustion of the field of North American botany. The plants have been nearly all described and well described, so there is nothing left to do except to describe them over again in new ways, or under new titles. If one will persist in threshing over and over old straw, and finds only an occasional kernel of grain as a reward, it is not unnatural that he should find amusement and even see importance in piling the heaps of straw in new and striking patterns. The subject seems to share with millstones and the human heart the necessity for grinding itself when it has nothing else to grind. Systematic botany is too conservative in its methods, especially among

us. It refuses to use new lines of research offered by embryology and comparative morphology, and except in the accumulation of more material and some refinement in details it is hardly less but rather more of a book and skeleton study than it was fifty years ago, or even to Linnaeus himself. The earnest worker in other fields, and indeed present popular opinion can hardly be blamed for considering a good deal of it, and especially wrangling over nomenclature, as of a very amateurish sort, employing the faculties of the postage stamp collector rather than those of the naturalist.

To sum up: I do not believe in and do not teach the nomenclature of the Madison Congress, because I do not believe it can possibly prevail. It violates the psychological principles of the use of language, it is not sanctioned by the leading authority of the systematic world, past nor present, and its advocates give us no guarantee that they can produce works on North American botany of greater authority than those already in existence; it is impossible to secure the cooperation of the foreign botanists; it overturns much that was sufficiently stable, to replace it by a new system which has not the element of stability, since it will not be able to induce future botanists to use it.—W. F. GANONG.

Dr. Robinson and homonyms.

In the preceding number of the GAZETTE Dr. B. L. Robinson has presented another of his fatal objections to the principles of nomenclature adopted by the Botanical Club of the American Association—namely, the principle of the rejection of homonyms as applied to binominals. In support of this objection he cites not a case known to science, but a wholly suppositious one, the occurrence of which is a matter of almost ridiculous improbability. It should be answer enough that this is a purely hypothetical objection, especially if we are to be guided by Dr. Robinson's previous utterance[1] that principles of nomenclature should not be laid on theoretical grounds. There probably will never occur a more glaring case of unscientific "lumping" of genera than that indulged in by Dr. Otto Kuntze when he united Bigelovia, Solidago, and Aplopappus with Aster, and yet even this lamentable piece of patchwork has not produced the chaotic results por-

[1] Recommendations regarding the nomenclature of systematic botany, p. 1. (May, 1895).

trayed by Dr. Robinson. The Botanical Club principles are explicit in this matter of homonyms, and the disposal of real cases, if any occur, presents no uncertainty and no difficulty to one who first reads the rule and then practices accordingly. Before discussing the practical validity of this objection we may at least ask that some actual cases be cited, and that the objection be not based solely on the alleged possibility of a preposterous publication on the part of some irresponsible botanist.

To illustrate the object and working of the rejection of homonyms as applied to binomials the following example will suffice. There is in the western United States a species of rush, closely related to *Juncus nodosus* and by some authors considered only a variety of it, but undoubtedly a good species and first treated as such in the year 1861 under the name *Juncus megacephalus* Wood. Now according to the Botanical Club rules this name is not tenable because Mr. M. A. Curtis as early as 1834 described under the same name, *Juncus megacephalus*, another rush which has been commonly known as *Juncus scirpoides echinatus*. According to Dr. Robinson's ideas, however, the name *Juncus megacephalus* Wood is entirely tenable, since *Juncus megacephalus* of Curtis was long since relegated to synonymy. This disposition appears at first sight to be satisfactory, but we may go a little further. A careful study of the group has shown that the variety *echinatus* is a valid species distinct from *J. scirpoides* and that it must stand under the name *Juncus megacephalus* Curtis. This would necessitate a change also in the name *Juncus megacephalus* Wood, since two species could not have the same name. According to Dr. Robinson, therefore, future critical work on this group, would entail a change not only in the name of the plant under examination but also in that of still another species having no relationship whatever with the first. According to the Association rules the name *Juncus megacephalus* Wood being untenable from the start would at once be changed and could in no way be affected subsequently by critical work on *Juncus scirpoides* and its varieties. The answer to the question which of these practices contributes to stability is evident.

In the last paragraph of his remarks Dr. Robinson introduces a depreciatory allusion to the botanists who attended the Madison meeting of the American Association, both as

to their number and their standing. This is a dangerous position, to say the least,—to challenge a public discussion of the relative scientific merits of prominent botanists. Consideration of such a question is in my opinion better left to each botanist for his personal and individual judgment. I must decline, therefore, to accept this tempting invitation, and content myself by giving a list, from memory, of some of the botanists present at the Madison meeting:

J. C. Arthur,	J. M. Coulter,	W. A. Kellerman,
Charles R. Barnes,	Frederick V. Coville,	Conway MacMillan,
Charles E. Bessey,	E. L. Greene,	B. L. Robinson,
N. L. Britton,	Byron D. Halsted,	W. T. Swingle,
Mrs. E. G. Britton,	A. S. Hitchcock,	Edwin B. Uline,
Douglas H. Campbell,	Arthur Hollick,	L. M. Underwood.

To these should be added the names of Henry H. Rusby, William Trelease, and Lester F. Ward, who although not present, voiced their approval as members of the nomenclature committee. Other professional botanists, whose names I do not at the moment recall, making the number of at least thirty, were present, besides the amateur botanists who customarily attend the meetings—altogether probably a larger and more broadly representative group of professional botanists than has ever attended a meeting of the American Association.

In his closing sentence Dr. Robinson gives vent to a statement as unfair in its implication as it is unwarranted in its assumption, to the effect that I have sought to decry any adverse criticism of the Association principles. What I did call attention to, and what I wish to point out again more plainly than before is that Dr. Robinson ignored the Association principles as long as possible, declined to discuss them at the times set for their discussion, and then after their final adoption conducted a "confidential" correspondence directed secretly against the reform. I doubt whether any committee could have given to nomenclatural principles more careful, deliberate, and judicial consideration than did the committee which prepared this code, and I repeat that Dr. Robinson's course, to say the least, seems to me wholly unjustifiable, assuming that he is working for the progress of systematic botany.—FREDERICK V. COVILLE.

BRIEFER ARTICLES.

A red-seeded dandelion in New England.—In June, 1892, my attention was called, by Mr. Chas. G. Atkins of East Orland, Maine, to a red-seeded dandelion, which grows abundantly in northwestern Hancock county. Mr. Atkins noted that the red seed were invariably associated with sparse foliage, and deeply cut leaves, and that the outer involucral bracts were not reflexed as in the ordinary Taraxacum. The color of the flowers, too, is a striking character as evidenced by Mr. Atkins's note, "where the two sorts were intermingled in a field I could (at a distance of several rods) detect the red-seeded sort by the brighter yellow of the flowers."

In May, 1894, Mr. N. T. Kidder, and others interested in the Flora of the Boston Metropolitan Parks, found the same form growing about the waterfall on Beaver Brook, at Waverly, Mass., and later the author detected it in some quantity with Cinna pendula, Eatonia Pennsylvanica, and Woodsia Ilvensis, in rocky woods near Pease Pond in Wilton, Maine.

During the present season it has been found in great abundance about Cambridge, Mass. Messrs. Emile F. Williams, Alfred S. Higgins and the author have found it plentiful in dry fields about Winchester, Mass., and in great abundance on the west ledges and cliffs in "Shaker Glen," East Lexington. In "Shaker Glen" the plant is associated with Anemonella thalictroides, Aquilegia Canadensis, Cardamine rhomboidea, Oryzopsis asperifolia, Adiantum pedatum, Cystopteris fragilis, and other species which point to the possibility that the Taraxacum is indigenous. In a recent visit to Kennebunkport, Maine, Mr. Warren H. Manning and the author found the plant everywhere on the ledges, both on the main land and on the islands off Cape Porpoise.

In all these stations no forms have been detected which show any intergradation with Taraxacum officinale, and until such forms may be found it seems desirable to follow DeCandolle, Liebmann and others in considering this a distinct species, rather than to give it varietal rank as has been done by Koch, Hooker, and Karsten. The following description and notes will summarise the points of distinction already suggested.

TARAXACUM ERYTHROSPERMUM Andrz. in Bess. Fl. Podal. cont. II. n. 1586. (*T. officinale* Weber, var. *glaucescens* Koch). Leaves dull green, glabrous, deeply runcinate-pinnatifid or even pinnately divided,

with narrowly triangular or lanceolate segments: scapes glabrous or very sparingly pubescent above, bearing small heads scarcely an inch across: involucral bracts glaucous, the outer lanceolate, 3–5 lines long, horizontally spreading or sub-erect, one or two with a corniculate appendage below the tip; the inner bracts linear, 6–9 lines long, nearly all with a corniculate appendage ½ line or so below the whitish tip: flowers 70–80, sulphur-yellow, the outer ligules conspicuously purplish without: achenes spindle shaped, bright red or reddish brown, the body 1½ lines long, sharply muricate above, gradually contracted to a narrowly-conical apex ¾ line long; the filiform beak barely twice the length of the achene, and with the pappus dirty white: fruiting receptacle rarely more than ¼ inch broad.—In dry or rocky places, Hartford, Maine, 1886 (J. C. Parlin); northwestern Hancock county, Maine, June, 1892 (C. G. Atkins); Waverly, Mass., May, 1894 (N. T. Kidder and others); Wilton, Maine, August, 1894 (M. L. Fernald); Lexington and Winchester, Mass., May, 1895 (E. F. Williams, A. S. Higgins and M. L. Fernald); Kennebunkport, Maine, May, 1895 (W. H. Manning and M. L. Fernald); and Cambridge, Mass.

The species seems well distinguished from *T. officinale*, which has larger and less cut leaves; larger, orange-yellow heads, with many more flowers (the specimens examined show from 170–190 in a head); involucral bracts larger, not glaucous, the outer conspicuously reflexed, and rarely with corniculate appendages; receptacle broader; achenes broader, less tapering above, olive green or greenish brown; the beak two or three times as long as the achene, and the pappus a purer white.—Merritt Lyndon Fernald, *Cambridge, Mass.*

Gilbreth Botanical Collection.—One of the most valuable and interesting gifts which have recently been presented to Radcliffe College is that of Mrs. Martha Bunker Gilbreth of Brookline, consisting of the botanical collections made by her daughter, Miss Mary E. Gilbreth, who died not long since. On the occasion of the formal presentation of the gift to the college—an occasion which drew together a large number of instructors, and representatives of the College Club, Idler Club, Home and Field Club, and other societies of which Miss Gilbreth was a member when she was a student in the college—Professor George L. Goodale, who made the presentation address, described the extent and value of Miss Gilbreth's collection and the relation which part of it bears to the great scientific problems of the time, and the light it throws upon them, prefacing his statement with a brief account of her life.

The part of her collection specially referred to by Professor Goodale is that illustrating the dissemination of plants by means of their seeds. . . .

The materials of the collection, which were gathered during the last ten or twelve years of Miss Gilbreth's life, for her own use as a student and teacher, are of three kinds: 1. Pressed specimens for an herbarium; 2. Material preserved in alcohol for microscopic study; 3. Dried specimens of fruits and seeds preserved in boxes to illustrate the dissemination of plants. . . .

The collection to illustrate the dissemination of plants is of special importance and, in fact, is thought to be unique in its design and extent among American botanical collections. The specimens of this collection have been placed in boxes of multiple sizes, arranged in trays of standard herbarium size and have been classified with reference to the agencies of dissemination as devised for: 1. Dissemination by gravitation; 2. Dissemination by water; 3. Dissemination by wind; 4. Dissemination by animals; and 5. Mechanical expulsion. Under each of these heads specimens are classified with reference to the device employed—as edible berry, hooked appendage, wing-like expansion, etc. Under each of these headings the special morphology of the part which serves the purpose is briefly stated, explaining what part of the plant is modified and in what way, to form the wing, hook or whatever the device may be.—Condensed from Boston *Transcript*, May 22, 1895.

Poisoning by shepherd's purse.—A case was reported to me recently by a competent and reliable physician, of severe poisoning of two children by eating the tops of shepherd's purse (*Bursa bursapastoris*). The effects were noticeable within half an hour and were so severe that the physician was called within two hours. He found the patients pale and exhausted; vomiting was frequent, the pulse very rapid and too feeble to be counted, breathing difficult; blood was vomited and one of the patients passed bloody urine.

Calcined magnesia and olive oil were administered, also whisky and digitalis. The symptoms continued severe for fifteen hours. Recovery followed. The children had been strong and healthy, and took nothing apparently that could have produced these symptoms except the shepherd's purse which they ate while going across the field to the place where their father was plowing.

I visited the locality on learning of the case and searched in the vicinity and over the immediate neighborhood for other plants that might have been taken by the children but could find nothing suspicious except very small quantities of Rhus radicans. I think it highly improbable that the children partook of this and besides they aver that they ate only the shepherd's purse.

A very few plants were found affected with albugose but the fungus

(*Albugo candidus*) causing this disease is not, I think, supposed to be poisonous. Even if so, it is doubtful whether the children ate any plant affected with this disease.

Are there cases on record, or known to any one, of poisoning by this plant?—W. A. KELLERMAN, *Columbus, Ohio.*

Viola sagittata Hicksii, var. nov.—Somewhat cespitose, from a thick ligneous rootstock; leaves hirsute pubescent, the earliest cordate, the later deltoid ovate, decurrent on the petiole, obtuse, remotely denticulate and nearly entire; flower nearly as in the type; fruiting peduncles more or less recurved; capsules pubescent; sides heavily marked or pitted.

Collected by Mr. Gilbert H. Hicks, of the U. S. Department of Agriculture, May 26, 1895, on a hillside in Rock Creek Park, D. C. Plants of the normal *V. sagittata* also occur at this locality, but are not plentiful, being outnumbered ten to one by the new variety. No other species grows there in sufficient quantity to warrant the supposition that this is a hybrid; its affinities are altogether with V. sagittata. The distinction lies in the habit of the plant: in the hirsute leaves, which never exhibit any sign of lobation: in the recurved fruiting capsules: and in the seeds, which are conspicuously, instead of obscurely, spotted.

There is a specimen of this variety in the National Herbarium, collected many years ago by Professor Ward, apparently at the same locality, with characters in every way identical with those of the rediscovered specimens. It will be interesting to note whether future observations will indicate a more extended range and the possibility of specific rank for the plant.—CHARLES LOUIS POLLARD, *Washington, D. C.*

An interesting Equisetum.—Through the kindness of Dr. J. M. Coulter, I have received a curious *lusus naturæ* in the form of an Equisetum, presumably *E. hiemale*, collected near Joliet, Illinois, by Miss Jessie E. Davison. A sketch of the plant is appended. It will be seen that in place of the ordinary growth into joints there has been a lateral growth of the stem and sheath so that there has resulted a spiral extension reminding one of the helicoid growth of *Riella helicophylla* as frequently figured (*Cf.* Goebel: Outlines, etc. 145). The plant is evidently distorted in this manner from some injury received early in its growth, but nevertheless forms a remarkable sport.—LUCIEN M. UNDERWOOD, *Greencastle, Ind.*

Fig. 1—ABNORMAL EQUISETUM. (Nat. size.)

CURRENT LITERATURE.

The natural history of plants.[1]

When we recently welcomed the announcement that Kerner's Pflanzenleben was to be translated into English and published by A. & C. Black, we did not even hope that an edition would be prepared for this country. The issue of such an edition by Messrs. Henry Holt & Co. is therefore a most agreeable surprise. The first volume, in two parts, dealing with forms and growth, is now before us, and the second volume is in press.

Professor Oliver has done English speaking botanists a favor in translating this work. But he has done more, for it is hardly necessary to say to botanists that the appearance of Kerner's work in English will do much towards bringing modern botany before the intelligent public. We need more of this kind of teaching that will bring those not professionally interested in botany to some realization of its scope and great interest. The fascinating style of the author, and his freedom from pedantry in the use of terms, have been admirably retained by the translator. In fact, nothing in the style reveals that the book is a translation, which can be said of very few of the scientific books that have come to us from Germany.

This lucidity, and the excellent illustrations, not only will introduce the non-botanical reader to the science of botany, but should serve as a lesson to the professional botanist in the art of presentation. As a source of material and illustration for lectures no book has been the equal of Kerner's Pflanzenleben; and its usefulness will be multiplied many fold now that students and amateurs can be referred to it.

The general subjects treated are: the living principle in plants; absorption of nutriment; conduction of food; formation of organic matter from the absorbed inorganic food; metabolism and transport of materials; growth and construction of plants; plant-forms as completed structures.

It will be seen that physiology and ecology are the dominant thoughts, and the latter is far too much neglected in these days of morphology and physiology. But the subjects listed do not do justice to the inter-

[1] KERNER, ANTON, von MARILAUN. The natural history of plants, their forms, growth, reproduction, and distribution. Translated from the German by F. W. Oliver, with the assistance of Marian Busk and Mary F. Ewart. Half-volumes I and II. Large 8vo. pp. 777, figs. 188, colored plates 8. New York: Henry Holt & Co. 1895. $7.50.

esting discussion and the lucid style. For instance, under "the living principle in plants," in addition to the ordinary treatment of protoplasm such a chapter as "communication of protoplasts with one another and with the outer world" gives new zest to the subject; and under "absorption of nutriment" the subjects of parasitism and symbiosis are discussed. More than all is to be commended that summary view of plants which considers them in relation to their environment, as organisms showing a resultant structure. It is time to suggest that the laboratory student should also become a student of nature, and that the purpose of our analysis is not fulfilled until it leads to synthesis.

A good word also needs to be said for the excellence of the volumes from the book-maker's point of view. When we say that the quality of the original edition is really surpassed we say what can rarely be said of such works. Typography, printing, colored plates, and binding leave nothing to be desired—except a lower price.

A new hand book of systematic botany.

The wonderful botanical activity of the last decade is bearing fruit in a sudden gush of text-books, and in no department are they more numerous than in taxonomy. Research has been so multiplied that results can be applied to the general subject, and schemes of classification are appearing with bewildering frequency. It is well to have Dr. Warming's book[1] introduced among English texts, for the Danish original and Knoblauch's German edition have long been recognized as important contributions to systematic botany. Professor Potter has given us much more than a faithful translation, for he has called in the aid of specialists in the revision of certain parts. He has also done excellent service in presenting in an appendix a comparative view of the different prominent schemes of classification. Aside from the fact that the matter is as fresh as the nature of the subject permits, certain peculiarities of presentation characterize the book. Five grand divisions are recognized, phanerogams being broken up into gymnosperms and angiosperms; a view which certainly commends itself in so far as it emphasizes the fact that gymnosperms are no more related to angiosperms than to pteridophytes. Perhaps, however, the group archegoniates is a better expression of the real relationships. The thallophytes are presented in three groups, the myxomycetes sharing rank with algæ and fungi. The classification of the fungi is by Dr.

[1] WARMING, DR. E. A hand book of systematic botany; translated and edited by M. C. Potter. 8vo. pp. 620, illustrated. New York: Macmillan & Co., 1895. $3.75.

Knoblauch, following the most recent researches of Brefeld. Among the angiosperms the sequence of orders is based upon opinions as to morphological simplicity and complexity. For instance, epigyny and perigyny are less simple than hypogyny; zygomorphy is younger than actinomorphy; forms with united leaves indicate younger types than those with free leaves; acyclic flowers are older than cyclic; and so on. Such a sequence is largely like many that precede it, differing only in minor details. In our opinion the most useful chapter of the book is that entitled "the transition from the cryptogams to the phanerogams," not that its facts are new, but because it is a compact presentation of what is often scattered. This particular "transition" may be no more important than several others, but the "gap" at that point has such a wide reputation that it is worth while to make a special effort to fill it. The Warming-Potter book is a very welcome one to American botanists.

Elements of botany.[1]

This little book is one of the series of Cambridge Natural Science Manuals, and is quite a commentary on the status of botany at that ancient university. It is rather startling to us that our trans-atlantic friends are compelled to put such primers in the hands of university students. It is too meager even for our secondary schools. We have been cursed with "fourteen weeks of botany," but fourteen days of botany is something appalling. Taking for granted that English botanists are not to blame for this state of affairs, but rather the mediaeval spirit of the universities, it becomes a matter of interest to see how our unfortunate brethren have accomplished this marvel of condensation. We believe that Mr. Darwin has done all that could be expected in the time at his command. How much better this is than nothing is another matter. He presents morphology, physiology, classification, anatomy, does not neglect the cryptogams, and does what is styled "practical work." The subjects of the fourteen practical exercises suggest the general range of the accompanying lectures. They are (1) the cell, (2) the seed and seedling, tubers, bulbs, (3) the root, (4) the herbaceous stem, (5) the arboreal stem, (6) phloem and cork, (7) the leaf, (8) reproduction, (9) the fern, (10) the reproduction of the fern, (11) the flower, (12) the flower, dichogamy, (13) the seed, (14) the fruit. Several examples are used under each study, so that a comparative view may be had. Well as the work has been done, our one thought is that of pity that it had to be done.

[1] DARWIN, FRANCIS; The elements of botany. Small 8vo. pp. 235; figs. 94. Cambridge (England) University Press. New York: Macmillan & Co. 1895.

Minor Notices.

A MOST COMMENDABLE undertaking has been begun by Mr. C. G. Lloyd of Cincinnati, Ohio. He is photographing the larger fungi, natural size, upon plates 6 by 8 inches. These are distributed to friends, and so great an acquisition are they that any one interested in fungi will consider himself exceedingly fortunate to be counted upon the list of recipients. The first distribution consisted of the three species: Morchella conica, Peziza badia, and Lycoperdon separans. The selection of specimens is excellent, and the photographic work is beyond all criticism. This distribution was so warmly received that Mr. Lloyd decided to change his original plan and use the photogravure process of reproduction. The second distribution, just made, includes Gyromitra brunnea and Polyporus squamosus. These are not so clear and striking as the photographic prints of the first distribution, but are still very handsome plates. Mr. Lloyd proposes to reissue the first three numbers by the photogravure process, provide descriptive text, and thus enable those who choose to bind the series in a uniform volume. Mr. A. P. Morgan is sponsor for the accuracy of the determinations. Although the issue is at present a complimentary distribution, the work is of so much value that we trust Mr. Lloyd will place some copies on sale for the benefit of the less fortunate part of the botanical public.

THE *Pflanzenphysiologische Versuche* of Oels, which was translated by D. T. MacDougal last year,[1] has been recast, and now appears from the publishing house of Henry Holt & Co. as a new work.[2] The book has been made more convenient and more satisfactory for general use than its predecessor, by a better arrangement of the subject matter, a clearer separation into chapters and paragraphs and the addition of titles to both paragraphs and experiments. Some substitutions and changes have been made in the illustrations, and also in minor features. The work as it now stands well meets the needs of high schools and colleges for a laboratory manual for elementary classes in vegetable physiology. It is, however, essentially the same work as Oels', and it seems to us that the compiler has scarcely given his chief source due credit by the scant acknowledgment in the preface that "the general form of Oels' manual has been retained . . . and a few paragraphs of the text have been repeated here without indication of their origin." Scientific men cannot be too scrupulous in this matter.

[1] See review in this journal **19**: 341.

[2] MACDOUGAL, D. T.—Experimental plant physiology. 8vo. pp. vi+88, illust. New York, Henry Holt & Co. 1895.

THE FACT THAT the first edition of "*The horticulturist's rule-book*"[1] was issued late in 1889, and that a third edition is now called for, is sufficient evidence that the book is appreciated by those for whom it is chiefly intended, viz., fruit growers, market gardeners, and florists. Yet there is information, compact and well-arranged, not only for them, but much that will be useful to any person who has a garden of any sort, or even a lawn to look after. In short, it is one of those handy reference books that ought to be found in every library. The name of the author—a guarantee of its reliability—the dainty and appropriate dress given it by its publishers, and the low price commend it at once to the intellect, the eye, and the pocket.

MANY STUDENTS of plants must also be entomologists enough to recognize insects at least in a general way. Flowers and insects are so closely related that insect manuals as well as phanerogam manuals must find a place upon the botanist's shelves. Professor Comstock has just published a work[2] which botanists should have. It is handsomely printed, profusely illustrated. and still so cheap that it should find ready sale. Numerous analytical keys direct the student to the larger groups, and the abundant figures still further simplify his determinations. We are also glad to note an attempt on uniform terminology based upon the study of homologies.

A WEED BULLETIN by L. H. Dewey has been issued by the U. S. Department of Agriculture as one of the Farmers' series (No. 28). It describes, with aid of cuts, ten of the weeds which have received most notice during the year, excluding the Russian thistle. These are Lactuca Scariola, Plantago aristata, Solanum Carolinense, S. rostratum, Amaranthus spinosus, Xanthium spinosum, Chondrilla juncea, Daucus Carota, Avena fatua, and Camelina sativa. Much practical information is given. Characteristics of one hundred weeds are briefly stated in form of a table.

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[1] BAILEY, L. H.—The horticulturist's rule-book, a compendium of useful information for fruit-growers, truck-gardeners, florists, and others. 3d ed., revised and extended. Small 8vo. pp. X + 302. New York: Macmillan & Co., 1895. 75 cents.

[2] COMSTOCK, JOHN HENRY AND ANNA BOTSFORD: A manual for the study of insects. Comstock Pub. Co., Ithaca, N. Y. 1895. 8vo. pp. 700, illustr., *net* $ 3.00.

OPEN LETTERS.

Identification of fossil leaves.

After reading the article "On the validity of some fossil species of Liriodendron," which I was kindly permitted to see in manuscript, I at first concluded that the personal nature of the contribution would render it impossible of comment by me. I have never yet entered into a personal controversy and do not care to begin now.

The author, has, however, given evidence of such remarkable failure to understand or appreciate the principles upon which paleobotany is founded that I shall say a few words on behalf of paleobotanists in general.

In the first place the mission of the paleobotanist is to describe and depict the fragments of vegetation with which he has to deal, in order that these fragments—a leaf, a fruit, a seed, a portion of a stem, etc.—may be recognized in the event of a similar fragment being found elsewhere at any future time. The naming of the fragment is an incident only, but it is a purely gratuitous assumption that earnest and conscientious thought and investigation are not given to this part of the work. The fragments are constantly coming to light, clamoring for recognition, and they cannot be ignored. It would be worse than folly to wait until perfect material should be found, before describing, merely because the exact affinities of a fossil fragment with our living flora could not be satisfactorily determined.

I am criticised for accepting the opinion of competent authorities in regard to the affinities of certain emarginate leaves from the cretaceous formation, with our living genus *Liriodendron*. While I am quite satisfied that the facts adduced warranted the inferences regarding this and other affinities, I am free to add that new material, recently collected on Long Island and Martha's Vineyard, will demonstrate the relationship even more clearly and, when described and published, will render any reference or reply to the foregoing paper unnecessary.

One other matter of principle needs to be touched upon. The possible relationship of the above mentioned leaves with the Leguminosæ is well taken, but this idea did not originate with the author. Unless however such relationship can be absolutely demonstrated, and the leaves referred without question to some living or extinct genus, a mere multiplication of synonymy would be inexcusable. So I shall continue to call the leaf found on Eaton's Neck, Long Island, *Colutea primordialis* Heer, not necessarily because I believe it to be placed in its correct genus or order, according to modern systematic botany, but because it is clearly the same species as the leaf described by Heer under that name from Greenland.—ARTHUR HOLLICK, *Columbia College, New York.*

NOTES AND NEWS.

JULIEN DEBY, well known for his study of diatoms, died recently in London after a long illness.

DR. EMIL KNOBLAUCH has become an assistant in the botanical institute of the University of Tübingen.

MR. E. FISCHER refers *Æcidium penicillatum* Müll. (Roestelia penicillata) to *Gymnosporangium tremelloides* A. Br.[1]

A HERBARIUM of five thousand sheets has been presented by Dr. J. P. Lotsy to the Women's College of Baltimore.

DR. GUNTHER RITTER BECK VON MANNAGETTA has been called to the a.-o. professorship of systematic botany in the University of Vienna.

MR. M. B. WAITE announces in *Science* that he has discovered a remedy for pear blight. He has been investigating the disease for several years.

THE FIELD MEETING of the Ohio Academy of Sciences was held at Sandusky, July 2nd and 3d, with an attractive series of short excursions to collecting localities in the vicinity.

THE SUM of $250,000 has been subscribed by citizens of New York city for a botanic garden, and the city is under obligation to contribute $500,000 more. The garden is now assured. It will be located in Bronx Park, and occupy 250 acres.

A NEW JOURNAL, *Allgemeine botanische Zeitschrift*, devoted to systematic botany, appeared with the year, under the editorship of A. Kneucker of Karlsruhe. It costs six marks per year, consists of at least sixteen pages per number, and appears on the 15th of each month.

MR. FRANK H. LAMB of Leland Stanford Jr. University has collected about Mazatlan, Santiago, San Blas and other points in western Mexico during the winter past. The collection has been determined at the Gray herbarium and sets of 200–250 species will be ready for distribution about October first.

WILD PARSNIPS, that is feral plants of Pastinaca sativa, which are popularly supposed to be poisonous, are considered by Prof. L. H. Pammel (Gard. & For. 8: 228) to be quite harmless. He adduces evidence to uphold his opinion, and explains the popular belief by supposing that Cicuta maculata has been mistaken for parsnip.

BY ORDER of the Secretary of Agriculture, the work of the Division of Microscopy, in the United States Department of Agriculture, ceased on July 1st. The Division of Chemistry, the Division of Vegetable Physiology and Pathology, and the Office of Fiber Investigations re-

[1] Hedwigia **34**: 1. 1895.

ceived the apparatus, specimens, books, etc., held by the Microscopist. This will be good news to those who have known the inefficiency of this ridiculously illogical division.

THE COLORADO SUMMER SCHOOL of science, philosophy and languages holds its fourth annual session from July 15th to August 16th. The situation of Colorado Springs is famous for its beauty and healthfulness, as it includes some of the most attractive Rocky Mountain scenery. The schedule of instruction embraces many subjects by distinguished educators. Botany is in charge of Professor Charles E. Bessey of the University of Nebraska.

THE Division of Vegetable Physiology and Pathology in the U. S. Department of Agriculture, has had under cultivation the past year something over one thousand varieties of wheat and oats. The grains have been collected from nearly all parts of the world, and have been grown chiefly for the purpose of obtaining information upon their rust-resisting qualities. Numerous crosses have been made, and material and facts obtained which will be used in further work.

THE AMERICAN NATURALIST has seemingly erected a new department, that of "vegetable physiology," under the editorship of Dr. Erwin F. Smith. As the editor takes a considerable part of the space in his initial number to attack the nomenclature movement, which can not be construed as having anything to do with physiology, it is not apparent why the items should not have appeared under the heading of "Botany," the department still edited by Dr. Charles E. Bessey.

A NEW DIRECTORY of botanists is in course of compilation by J. Dörfler, of the I. R. Court Museum and long at the head of the botanical exchange society of Vienna. It is intended to be a complete list of botanists, botanical gardens, institutes, societies and publications, both periodical and official, of all countries. Botanists will confer a favor by sending their full names, addresses and specialties; and directors of gardens or institutes are particularly requested to send lists of all employees whose names ought to appear in such a directory. Mr. Dörfler's address is Wien I, Burgring 7, Austria.

GŒBEL'S sixth contribution, under the title Archegoniatenstudien (Flora 80: 1. 1895), is on the function and formation of elaters. He finds their biological significance to be double; (1) they function, particularly when young, as conductors of nutriment to the sporogenous cells; and, (2) when mature, as distributors of the spores. The latter object (not by any means the subordinate one Leclerc du Sablon suggests it to be), is accomplished in two ways; (1) either by acting as slings, energetically hurling away the spores at the moment of drying, as in the greater number of forms; or (2) by their slight elastic movements loosening up the tangle of spores and elaters so that it may be readily carried away by gentle air currents.

POLYEMBRYONY is not an uncommon phenomenon and arises from various causes. One of the most interesting cases was described a few years ago by Dodel in *Iris Sibirica*, and by Overton in *Lilium Martagon*, who showed that one embryo arose from the egg and another from one of the synergidæ. Now S. Tretjakow announces the forma-

tion of one or even three embryos from the antipodal cells of *Allium odorum*. Fertilization is micropylar, and a normal embryo arises from the egg and sometimes another from a synerg. The antipodal embryos are not the result of fertilization, he thinks, but offer an instance of apogamy in the development of prothallial tissue into a sporophyte. (Cf. Ber. d. deutsch. bot. Gesells 13: 13. 1895.)

DR. J. GRUESS has adapted the reaction between diastase, guaiacum, and hydrogen peroxide to the microchemical recognition of diastase. Objects to be tested are to be laid, for a time sufficient to be permeated by it, in a dark brown solution of gum guaiacum in absolute alcohol. The alcohol is then allowed to evaporate and the object brought into a more or less dilute solution of H_2O_2, which colors the precipitated diastase of the cells a beautiful blue. By the use of this test, controlled by others, Grüss claims to have established the theory of Haberlandt which ascribes the secretion of diastase to the aleurone layer of grass seeds. He also finds that diastase is produced by the endosperm and cotyledonary tissues, and refutes the statements of Brown and Morris. (Cf. Ber. d. deutsch bot. Gesells. 13: 1. 1895.)

RECENT STATION BULLETINS comprise one upon local flora, two upon weeds and five upon diseases and their treatment. "The early flora of the Truckee valley" by Fred H. Hillman (Nev. no. 24) is an excellent manual of the spring flowers of the region. "The Russian thistle" is treated by Charles H. Shinn (Cal. no. 107) and by G. P. Clinton (Ill. no. 39), with illustrations. "Treatment of common diseases and insects injurious to fruits and vegetables," presumably by S. A. Beach (N. Y. no. 86) is a concise practical manual with index (56 pages). This station adopts the objectionable method of suppressing the names of those who write its bulletins. "Some special orchard treatment of the apple, pear and quince" by L. F. Kinney (R. I. no. 31); "Spraying of orchards: apples, quinces, plums," by E. G. Lodeman (Cornell no. 86); and "Prevention of potato blight" by H. H. Lamson (N. H. no. 22); all three have in view the use of Bordeaux mixture. "Damping off," by Geo. F. Atkinson (Cornell no. 94), is chiefly devoted to *Artotrogus* (Pythium) *Debaryanus* (Hesse), *A. intermedius* (De Bary), *Completoria complens* Lohde and *Volutella leucotricha* n. sp. (40 pages).

A CIRCULAR has been issued by Dr. Wm. Trelease, director of the Missouri Botanical Garden, calling the attention of botanists to the facilities afforded for research at the garden. In establishing and endowing the garden, its founder, Henry Shaw, desired among other things to provide facilities for advanced research in botany and cognate sciences. For this purpose, additions are being made constantly to the number of species cultivated in the grounds and plant houses, and to the library and herbarium, and, as rapidly as it can be utilized, it is proposed to secure apparatus for work in vegetable physiology, etc., the policy being to secure a good general equipment in all lines of pure and applied botany, and to make this equipment as complete as possible for any special subject on which original work is undertaken by competent students. All the facilities of the garden will be freely placed at the disposal of persons competent to carry on research work of value in botany or horticulture, subject only to such simple restrictions as are

necessary to protect the property of the garden from injury or loss. Persons who wish to make use of them are invited to correspond with the director, outlining with as much detail as possible the work they desire to do, and giving timely notice so that provision may be made for the study of special subjects. Those who have not published the results of original work should state their preparation for any investigation they propose to undertake.

TWO MOST IMPORTANT papers on physiological topics have recently been published in the Philosophical Transactions of the Royal Society of London, by Mr. F. Frost Blackman of St. John's College, the senior demonstrator in botany in the University of Cambridge. The first of these[1] describes a new method of investigating the carbonic acid exchanges of plants, by means of a most ingenious combination of respiratory (*resp.* assimilatory) absorption and titration chambers with aspirators and pressure bulbs. The apparatus is in duplicate to allow continuous observations, and while very complicated in connection is very simple to manipulate, requiring only the turning of stop-cocks. The aim is to absorb by baryta water the CO_2 in the air which has been drawn over the plant, to titrate the whole of the baryta water with HCl, using phenol-phthalein as an indicator, and then to empty the absorption tube without ever permitting the access of atmospheric air to the interior of the apparatus or interrupting the observations.

Working with this apparatus, Mr. Blackman reaches in his second paper[2] the following results, which set some matters in a new light, and demand careful consideration:

1. Under normal conditions, practically the sole pathway for CO_2 into or out of the leaf is by the stomata.

2. In young leaves the cuticle seems to be no more permeable to CO_2 than in mature leaves.

3. If the stomata be mechanically blocked an appreciable osmosis of CO_2 may take place through the cuticle provided that the tension of the CO_2 be great enough.

4. The normal amount of CO_2 in the atmosphere is not sufficient to produce any appreciable osmosis into a leaf with its stomata blocked; assimilation therefore cannot continue under these conditions.

5. The experimental optimum of CO_2 for assimilation depends on the structural porosity of the leaf, so that if this be reduced by blocking the stomata even pure CO_2 may not quite effect optimal assimilation.

6. To this, and not to the stomata being inoperative in gaseous exchange (which was Boussingault's view), is due the fact that in concentrated CO_2 a leaf with its stomata open assimilates less than one with the stomata blocked.

7. In bright light a fully green leaf assimilates all the CO_2 that it is forming by respiration, and none escapes from it. Garreau's demonstration to the contrary is only an expression of the imperfection of the conditions under which it was performed.

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[1] l. c. **186 B:** 485–502. 1895.
[2] l. c. **186 B:** 503–562. 1895.

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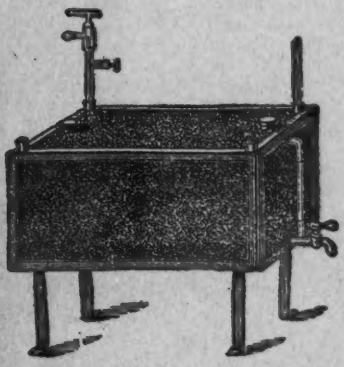

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